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TNT EQUIVALENCY OF RDX

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18. SUPPLEMENTARY NOTES

This project was accomplished as part of the U.S. Army's Manufacturing Methods and Technology program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in production of Army materiel.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

TNT equivalency	Fireball duration
RDX	MMT-Ammunition
Shipping containers	
Transfer container (Nutsche)	
Fireball diameter	

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Peak side-on blast overpressure and scaled positive impulse have been measured for RDX using configurations typical in a manufacturing facility. Quantities of 22.68 kg (50 lb), 45.36 kg (100 lb), 27.22 kg (60 lb), and 54.4 kg (120 lb) were tested in simulated shipping drums and simulated Nutsche containers. High explosive equivalency values for each test size were obtained as a function of scaled distance by comparison to known pressure and impulse characteristics for TNT surface bursts

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SUMMARY

High explosive RDX was detonated in scaled down configurations representative of the transfer container (Nutsche) and the shipping container typical in a manufacturing facility. Blast output parameters were measured and TNT equivalency was computed based on comparison with TNT hemispherical surface bursts. The results are shown in the table below.

Within experimental error, the pressures were greater than 100% at all scaled distances in all configurations. Impulse equivalencies were greater than 100% at the near-field scaled distances ≤ 2.14 m/kg$^{1/3}$ (5.4 ft/lb$^{1/3}$), and varied above and below 100% at the far-field scaled distances ≥ 3.57 m/kg$^{1/3}$ (9 ft/lb$^{1/3}$). Test results indicated that pressure and impulse values were dependent upon geometry (transfer container versus shipping container) and, to within experimental error, scaled according to the cube root of the charge weight. These high equivalency results are consistent with tests performed on C4[1] and A3[2] which contain high percentages of RDX. It is recognized that charge shape has a significant effect on airblast parameters. Studies of cylinders, spheres, and hemispheres show the equivalency to be variable with scaled distance.[3] Airblast measurements from spherical and hemispherical surface bursts of TNT are well documented in many other literature sources concerning airblast phenomenon. In comparing the RDX airblast measurements to TNT hemispherical data it should be noted that pressure and impulse changes are relatively insensitive to weight changes ($Z \approx 1/w^{1/3}$), however equivalent weights amplify the pressure (or impulse) differences.[4]

Configuration	TNT Equivalency (%) at Scaled Distance											
	1.19 m/kg$^{1/3}$ (3.0 ft/lb$^{1/3}$)		1.59 m/kg$^{1/3}$ (4.0 ft/lb$^{1/3}$)		2.14 m/kg$^{1/3}$ (5.4 ft/lb$^{1/3}$)		3.57 m/kg$^{1/3}$ (9.0 ft/lb$^{1/3}$)		7.14 m/kg$^{1/3}$ (18.0 ft/lb$^{1/3}$)		15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$)	
	P	I	P	I	P	I	P	I	P	I	P	I
Simulated shipping drum 22.68 kg (50 lb) charge	350	150	413	155	210	120	150	144	200	70	259	54
Simulated shipping drum 45.36 kg (100 lb) charge	329	102	423	126	246	120	147	77	156	102	244	55
Simulated Nutsche container 27.22 kg (60 lb) charge	493	135	540	254	367	258	172	94	116	113	223	67
Simulated Nutsche container 54.43 kg (120 lb) charge	526	113	515	241	316	232	148	75	132	107	255	39

CONTENTS

TABLES

INTRODUCTION

BACKGROUND

Tests were conducted under Project No. 5794285, TNT Equivalency, as an engineering effort to provide TNT equivalency data in support of Project 5873000.

The tests covered those configurations which are to be encountered at sensitive locations at the explosive manufacturer's facility. These configurations are the transfer container (Nutsche) and the shipping container. The amounts of RDX in these configurations are 544.3 kg (1200 lb) and 90.7 kg (200 lb). The large weights contained in these configurations were scaled down for these tests.

OBJECTIVE

The objective of these tests was to determine the maximum output from the detonation of RDX explosive in terms of the peak airblast overpressure and positive impulse. The measured pressure and impulse data will be compared with known TNT test data to determine the equivalency of RDX explosive in relation to TNT.

EXPERIMENTAL METHODS

MATERIALS

The test material was RDX, high explosive, Batch No. 4RA59-217, Lot No. HOL 80A675-027. The explosive was received from Holston Army Ammunition Plant in standard shipping containers with a dry weight of 72.57 kg (160 lb) and a gross weight of approximately 113.4 kg (250 lb). The RDX was received and tested in the wet condition. The wetting agent was isopropyl alcohol.

TEST PLAN

Airblast output was evaluated for weights and configurations of RDX representing bulk RDX in a scaled down simulated Nutsche and a simulated drum. Physical characteristics of the test items are as follows:

(1) A cylindrical container (figure 1a) with a charge weight of 22.68 kg (50 lb) of RDX was used to simulate the shipping drum with a dimensional scaling factor of 0.63. The container was constructed from fiberboard with a height of 42.93 cm (16.9 in) and a diameter of 29.22 cm (11.7 in).

(2) A cylindrical container (figure 1b) with a charge weight of 45.36 kg (100 lb) of RDX was used to simulate the shipping drum with a dimensional scaling factor of 0.63. The container was constructed from fiberboard with a height of 53.34 cm (21.0 in) and a diameter of 37.34 cm (14.7 in).

(3) An orthorhombic container (figure 1c) with a charge weight of 27.22 kg (60 lb) of RDX was used to simulate the transfer container (Nutsche) with a dimensional scaling factor of 0.37. The container was constructed from plywood with dimensions of 46.74 cm (18.4 in) long by 29.97 cm (11.8 in) wide by 22.68 cm (9.0 in) high. The long side of the container was positioned facing the even gage line.

(4) An orthorhombic container (figure 1d) with a charge weight of 54.43 kg (120 lb) of RDX was used to simulate the transfer container (Nutsche) with a dimensional scaling factor of 0.46. The container was constructed from plywood with dimensions of 58.42 cm (23.0 in) long by 37.59 cm (14.8 in) wide by 27.94 cm (11.0 in) high. The long side of the container was positioned facing the even gage line.

Each test charge was initiated with a J2 blasting cap and a conically shaped booster of composition C4 high explosive. The weight of C4 used was 2 percent of the charge weight for each test. The C4 was shaped conically with an aspect ratio of 1:2 h/w. The C4 was centered on top of the RDX in the simulated Nutsche container and shipping drum and the blasting cap inserted at the apex and embedded to the center of the cone.

The test charge for each configuration was placed on a mild steel witness plate 1.27 cm (0.5 in) thick with the outside dimensions being 5.08 cm (2 in) larger than the base of the test configuration dimensions. Figure 2 shows the test area. The area was refurbished after each test subsequent to measurement of crater diameter and depth.

INSTRUMENTATION

Twelve PCB Piezotronics, Inc. side-on pressure transducers were mounted and placed at ground level in two 90° arrays within the test area shown in figure 2. Distances between the transducers and charge were calculated to correspond to scaled distances of 1.19, 1.59, 2.14, 3.57, 7.14 and 15.87 $m/kg^{1/3}$ (3.0, 4.0, 5.4, 9.0, 18.0 and 40.0 ft/$lb^{1/3}$). The transducers were individually calibrated prior to each test series with quasi-static pressure pulses using a standard solenoid-actuated air pressure calibration fixture, adjusted to correspond to expected blast pressures based on an assumed TNT equivalency of 100%. Signal line continuity and channelization were checked prior to each test. Details of distances between charge and transducers, calibration pressures, and expected peak blast pressure at each distance are shown in table 1.

Before and after color still photographs were taken of each test setup and posttest configuration. Motion picture coverage consisted of a 16mm color movie (500 frames per second) for a single test of each test series and a documentary of 24 frames per second. Both cameras were pointed down the center line of the even gage line. Fiducial markers were positioned behind the test setup at 3.5 m (10 ft) intervals. Typical camera location and fiducial marker locations are shown in figure 3.

Figure 1a. Simulated shipping drum (scaled)

42.93 cm (16.9 in)

29.72 cm (11.7 in)

Figure 1b. Simulated shipping drum (scaled)

53.34 cm (21.0 in)

37.34 cm (14.7 in)
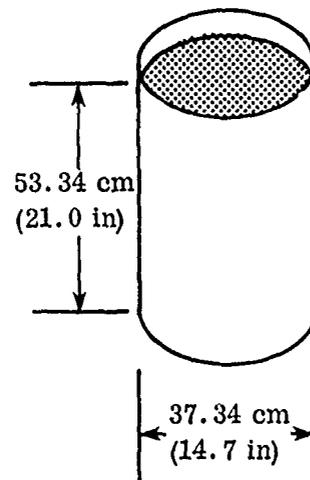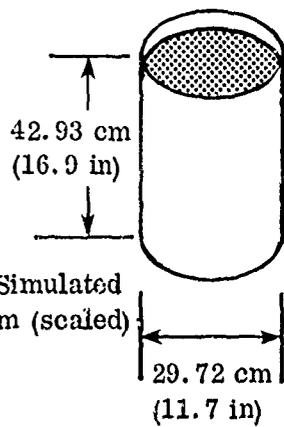
(Shaded area denotes approximate height of explosives in the drum or container.)

29.97 cm (11.8 in)

22.86 cm (9.0 in)

46.74 cm (18.4 in)

Figure 1c. Simulated Nutsche container (scaled)

37.59 cm (14.8 in)

27.94 cm (11.0 in)

58.42 cm (23.0 in)

Figure 1d. Simulated Nutsche container (scaled)
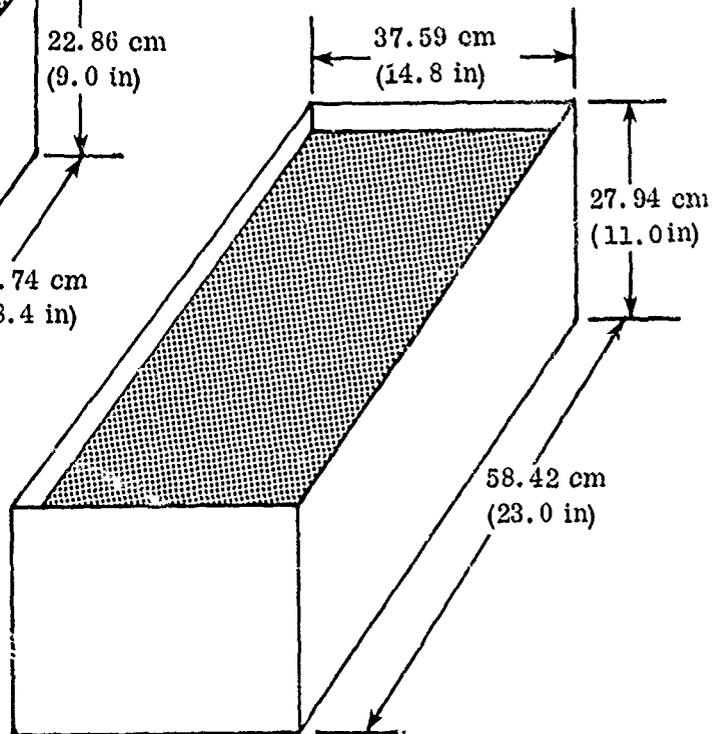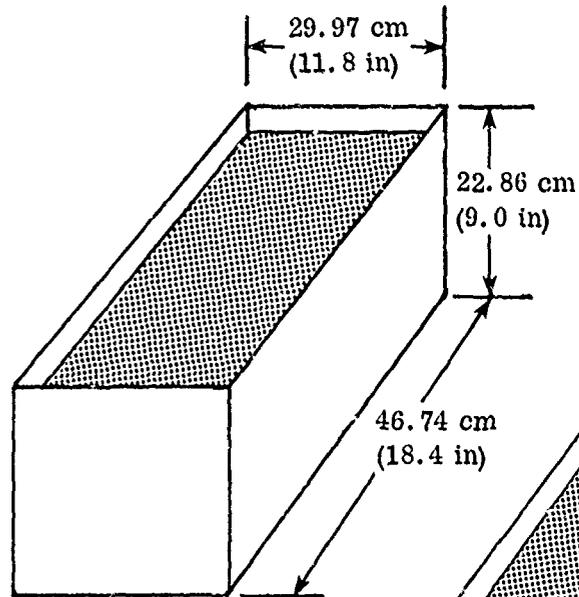
Figure 1. Test container configuration

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N

Booster

Firing circuit

Test material

Pressure
transducers

3.05m

Steel witness
plate

3.05m

Long face
of box

15 cm deep
sand box
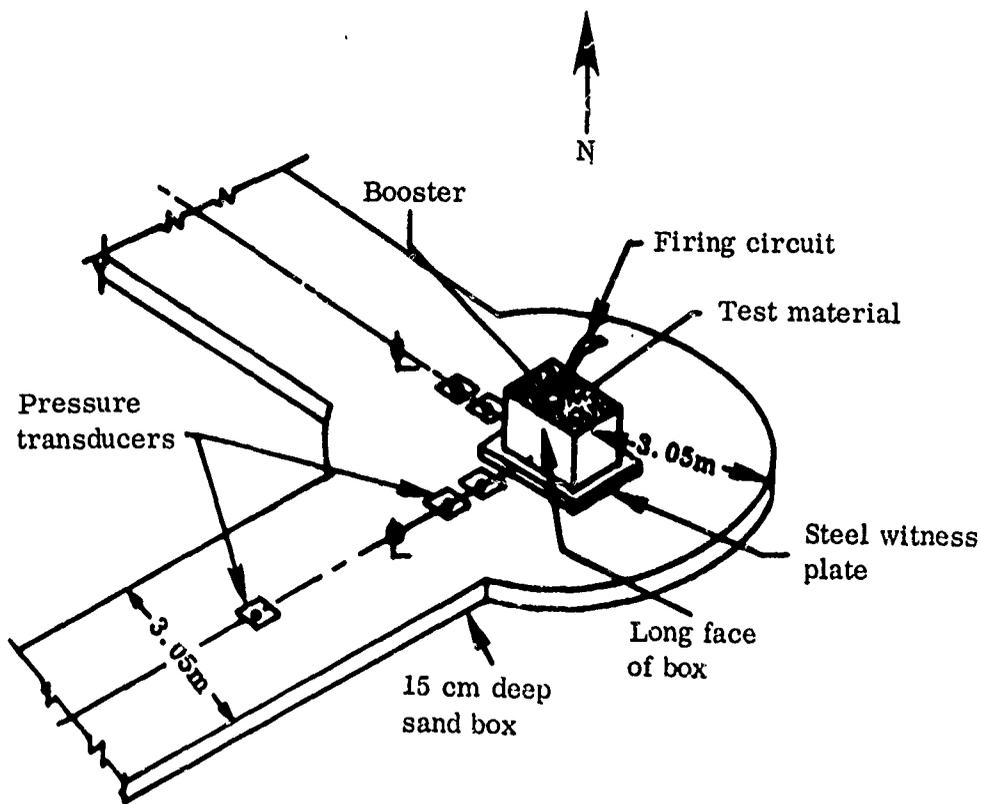
Figure 2. Typical charge placement for equivalency tests

N

3.05 m (10 ft)

Fiducial markers

#11   #9   #7   #5   #3 #1

#2
#4

#6

#8

#10

● Pressure Transducer
   Placement
X Fiducial Markers
■ Explosive Charges

#12

Mitchell color (24 fps)

Hycam-color (500 fps)

To test control
center
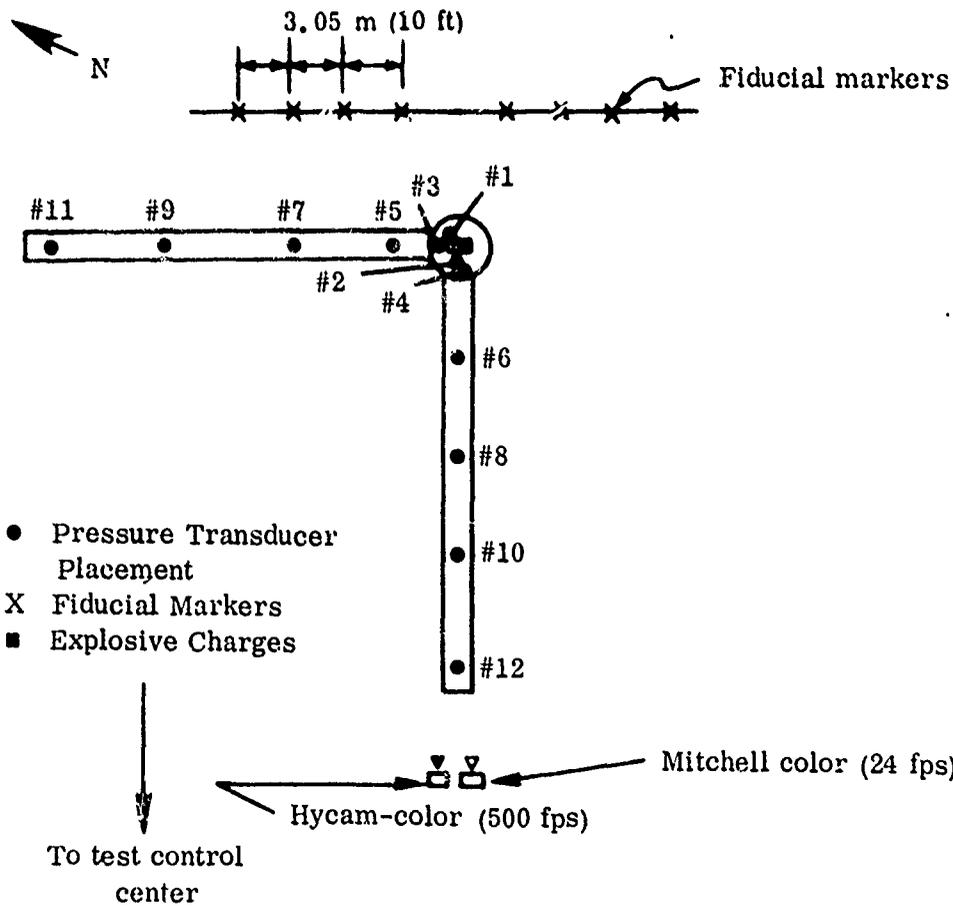
Figure 3. Test area showing transducer and camera placement

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Table 1. Transducer calibration and placement

Channel number	Scaled distance $m/kg^{1/3}$ $(ft/lb^{1/3})$	Full-Scale calibration pressure kPa (psi)	Expected pressure kPa (psi)	R_1 distance in meters (ft) from charge			
				Charge weight 27.22 kg (60 lb)	Charge weight 54.43 kg (120 lb)	Charge weight 22.68 kg (50 lb)	Charge weight 45.36 kg (100 lb)
1 2	1.19 (3.0)	1034 (150)	922 (133.71)	3.58 (11.75)	4.51 (14.80)	3.37 (11.05)	4.24 (13.92)
3 4	1.59 (4.0)	517 (75)	480 (69.58)	4.77 (15.66)	6.01 (19.73)	4.49 (14.74)	5.66 (18.57)
5 6	2.14 (5.4)	345 (50)	243 (35.17)	6.44 (21.14)	8.12 (26.64)	6.06 (19.89)	7.64 (25.06)
7 8	3.57 (9.0)	103 (15)	81.5 (11.82)	10.74 (35.23)	13.53 (44.39)	10.11 (33.16)	12.73 (41.77)
9 10	7.14 (18.0)	34.5 (5)	24.07 (3.49)	21.48 (70.47)	27.06 (88.78)	20.21 (66.31)	25.47 (83.55)
11 12	15.87 (40.0)	34.5 (5)	8.14 (1.18)	47.73 (156.60)	60.14 (197.3)	44.92 (147.36)	56.59 (185.66)

RESULTS

DATA ANALYSIS

Peak blast overpressure and positive impulse information were obtained in digital form. Data that could be attributed to instrumentation or explosive malfunction were excluded. The mean and standard deviation were then obtained and all data which fell outside two standard deviations were excluded from the TNT equivalency calculations. The data were then compared to data from TNT Hemispheres.[5] A computer program is employed which utilizes an iterative process that factors out the contribution of the booster charge weight and calculates the pressure and impulse equivalencies.[6] The calculated TNT equivalencies were arranged in tabular form and also plotted as functions of sample scaled distance. The standard curve for TNT hemisphere reference data is shown in figure 4.

TEST RESULTS

Data sheets for all tests with pertinent measured parameters are given in Appendix A. Selected pretest and posttest still photographs are given in Appendix B. Test numbers shown are for local reference only and provide access to original range data files. Average pressure and scaled positive impulse are summarized by test configuration in tables 2 through 5 and figures 5, 7, 9, and 11. Plots of pressure and scaled impulse equivalency are given in figures 6, 8, 10, and 12. Deviation from cube root scaling is shown in figure 13. Fireball diameter and duration as measured from the high speed motion picture are given in table 6.

DISCUSSION

Plots of peak pressure and scaled positive impulse for the simulated shipping drum with a charge weight of 22.68 kg (50 lb) are shown in figure 5. The plots of TNT equivalencies for pressure and scaled impulse are shown in figure 6. Pressure values were greater than expected at all scaled distances. Pressure equivalency values were greater than 100% at all scaled distances. At a near-field value of 1.59 $m/kg^{1/3}$ (4.0 $ft/lb^{1/3}$) the pressure equivalency was 413% for the highest value ranging to a low of 150% at 3.57 $m/kg^{1/3}$ (9.0 $ft/lb^{1/3}$) and increasing to a value of 259% at the far-field value of 15.87 $m/kg^{1/3}$ (40.0 $ft/lb^{1/3}$). Scaled impulse values were greater than expected except at the far-field values of ≥ 7.14 $m/kg^{1/3}$ (18 $ft/lb^{1/3}$). Scaled impulse equivalencies were greater than 100% at all scaled distances except at the far-field values of ≥ 7.14 $m/kg^{1/3}$ (18 $ft/lb^{1/3}$). At a near-field value of 1.59 $m/kg^{1/3}$ (4.0 $ft/lb^{1/3}$) the scaled impulse equivalency was 155% for the highest value ranging to a low of 54% at a scaled distance of 15.87 $m/kg^{1/3}$ (40.0 $ft/lb^{1/3}$).

Plots of peak pressure and scaled positive impulse for the simulated shipping drum with a charge weight of 45.36 kg (100 lb) are shown in figure 7. The plots of TNT equivalencies for pressure and scaled impulse are shown in figure 8. Pressure values were greater than expected at all scaled distances. Pressure equivalency values were greater
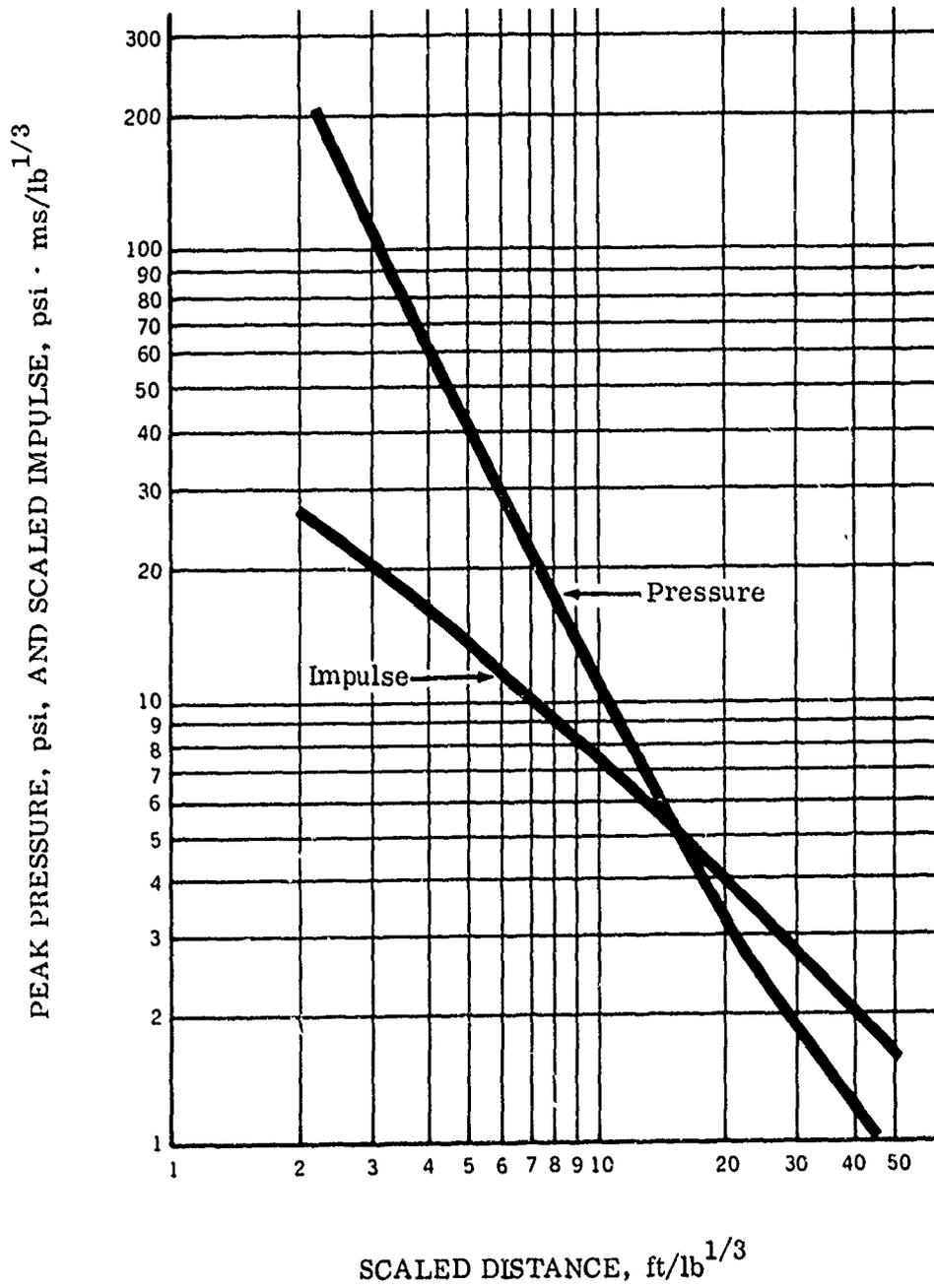
Figure 4.   TNT hemisphere reference data.

than 100% at all scaled distances. At a near-field value of 1.59 m/kg$^{1/3}$ (4.0 ft/lb$^{1/3}$) the pressure equivalency was 423% for the highest value ranging to a low of 147% at 3.57 m/kg$^{1/3}$ (9.0 ft/lb$^{1/3}$) and increasing to a value of 244% at the far-field value of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$). Scaled impulse equivalencies were greater than 100% at all scaled distances except at a scaled distance of 3.57 m/kg$^{1/3}$ (9.0 ft/lb$^{1/3}$) and at a scaled distance of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$). At a near-field value of 1.59 m/kg$^{1/3}$ (4.0 ft/lb$^{1/3}$) the impulse equivalency was 126% for the highest value ranging to a low of 55% at a scaled distance of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$).

The plots of peak pressure and scaled impulse versus scaled distance for the simulated shipping drum for charge weights of 22.68 kg (50 lb) and 45.36 kg (100 lb) show the same general trend. Pressure and scaled impulse TNT equivalencies as a function of scaled distance are similar.

Plots of peak pressure and scaled positive impulse for the simulated Nutsche container with a charge weight of 27.22 kg (60 lb) are shown in figure 9. The plots of TNT equivalencies for pressure and scaled impulse are shown in figure 10. Pressure values were greater than expected at all scaled distances. Pressure equivalency values were greater than 100% at all scaled distances. At a near-field value of 1.59 m/kg$^{1/3}$ (4.0 ft/lb$^{1/3}$) the pressure equivalency was 540% for the highest value ranging to a low of 116% at the far-field value of 7.14 m/kg$^{1/3}$ (18.0 ft/lb$^{1/3}$) and increasing to a value of 223% at the far-field value of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$). Scaled impulse values were greater than expected except at the scaled distances of 3.57 m/kg$^{1/3}$ (9.0 ft/lb$^{1/3}$) and 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$). At a near-field value of 2.14 m/kg$^{1/3}$ (5.4 ft/lb$^{1/3}$) the impulse equivalency was 258% for the highest value ranging to a low of 67% at a scaled distance of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$).

Plots of peak pressure and scaled positive impulse for the simulated Nutsche container with a charge weight of 54.43 kg (120 lb) are shown in figure 11. The plots of TNT equivalencies for pressure and scaled impulse are shown in figure 12. Pressure values were greater than expected at all scaled distances. Pressure equivalency values were greater than 100% at all scaled distances. At a near-field value of 1.19 m/kg$^{1/3}$ (3.0 ft/lb$^{1/3}$) the pressure equivalency was 526% for the highest value ranging to a low of 132% at the far-field value of 7.14 m/kg$^{1/3}$ (18.0 ft/lb$^{1/3}$) and increasing to a value of 255% at the far-field value of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$). Scaled impulse values were greater than expected except at the scaled distance of 3.57 m/kg$^{1/3}$ (9.0 ft/lb$^{1/3}$) and 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$). At a near-field value of 1.59 m/kg$^{1/3}$ (4.0 ft/lb$^{1/3}$) the scaled impulse equivalency was 241% for the highest value ranging to a low of 39% at a scaled distance of 15.87 m/kg$^{1/3}$ (40.0 ft/lb$^{1/3}$).

The plots of peak pressure and scaled impulse versus scaled distance for the simulated Nutsche container for charge weights of 27.22 kg (60 lb) and 54.43 kg (120 lb) show the same general trend. Pressure and scaled impulse TNT equivalencies as a function of scaled distance are similar.

Figure 13 is a graphic presentation of the deviation from cube root scaling for the 22.68 kg (50 lb), 45.36 kg (100 lb), 27.22 kg (60 lb), and 54.43 kg (120 lb) charge weights

Table 2. Summary of Test Results of 22.68 kg (50 lb) charge
simulated shipping drum scaled

Radius Meters (ft)	Scaled Distance $M/kg^{1/3}$ $(ft/lb^{1/3})$	Peak Pressure kPa (psi)	Scaled Positive Impulse $kPa.ms/kg^{1/3}$ $(psi\ ms/lb^{1/3})$	Pressure TNT Equivalency %	Impulse TNT Equivalency %
3.37 (11.05)	1.19 (3.0)	2289 (331.91)	217 (24.16)	350	150
4.49 (14.74)	1.59 (4.0)	1350 (195.78	177 (19.68)	413	155
6.06 (19.89)	2.14 (5.4)	427 (61.86)	119 (13.26)	210	120
10.11 (33.16)	3.57 (9.0)	108 (15.64)	87 (9.68)	150	144
20.21 (66.31)	7.14 (18.0)	35.1 (5.09)	28 (3.15)	200	70
44.92 (147.36)	15.87 (40.0)	12 (1.75)	11.8 (1.31)	259	54

Table 3. Summary of test results of 45.36 kg (100 lb) charge
simulated shipping drum scaled

Radius Meters (ft)	Scaled Distance $M/kg^{1/3}$ $(ft/lb^{1/3})$	Peak Pressure kPa (psi)	Scaled Positive Impulse $kPa.ms/kg^{1/3}$ $(psi\ ms/lb^{1/3})$	Pressure TNT Equivalency %	Impulse TNT Equivalency %
4.24 (13.92)	1.19 (3.0)	2188 (317.25)	174 (19.41)	329	102
5.66 (18.57)	1.59 (4.0)	1390 (201.63)	156 (17.43)	423	126
7.64 (25.06)	2.14 (5.4)	474 (68.69)	118 (13.18)	246	120
12.73 (41.77)	3.57 (9.0)	105 (15.26)	59 (6.56)	147	77
25.47 (83.55)	7.14 (18.0)	30.5 (4.43)	37 (4.16)	156	102
56.59 (185.66)	15.87 (40.0)	12 (1.75)	11.7 (1.30)	244	55

Table 4. Summary of test results of 27.22 kg (60 lb) charge simulated Nutsche container scaled

Radius Meters (ft)	Scaled Distance $M/kg^{1/3}$ $(ft/lb^{1/3})$	Peak Pressure kPa (psi)	Scaled Positive Impulse $kPa.ms/kg^{1/3}$ $(psi\ ms/lb^{1/3})$	Pressure TNT Equivalency %	Impulse TNT Equivalency %
3.58 (11.745)	1.19 (3.0)	2941 (426.46)	206 (22.99)	493	135
4.77 (15.66)	1.59 (4.0)	1655 (240.04)	234 (26.02)	540	254
6.44 (21.14)	2.14 (5.4)	644 (93.39)	186 (20.76)	367	258
10.74 (35.234)	3.57 (9.0)	119 (17.24)	66 (7.39)	172	94
21.48 (70.468)	7.14 (18.0)	25.6 (3.72)	40 (4.49)	116	113
47.73 (156.595)	15.87 (40.0)	11.4 (1.65)	13 (1.45)	223	67

Table 5. Summary of test results of 54.43 kg (120 lb) charge simulated Nutsche container scaled

Radius Meters (ft)	Scaled Distance $M/kg^{1/3}$ $(ft/lb^{1/3})$	Peak Pressure kPa (psi)	Scaled Positive Impulse $kPa.ms/kg^{1/3}$ $(psi\ ms/lb^{1/3})$	Pressure TNT Equivalency %	Impulse TNT Equivalency %
4.51 (14.80)	1.19 (3.0)	3061 (444.00)	184 (20.48)	526	113
6.01 (19.73)	1.59 (4.0)	1608 (233.19)	230 (25.59)	515	241
8.12 (26.64)	2.14 (5.4)	620 (89.87)	174 (19.35)	316	232
13.53 (44.39)	3.57 (9.0)	106 (15.41)	58 (6.50)	148	75
27.06 (88.78)	7.14 (18.0)	27.7 (4.02)	37 (4.17)	132	107
60.14 (197.3)	15.87 (40.0)	12.1 (1.76	9 (1.02)	255	39
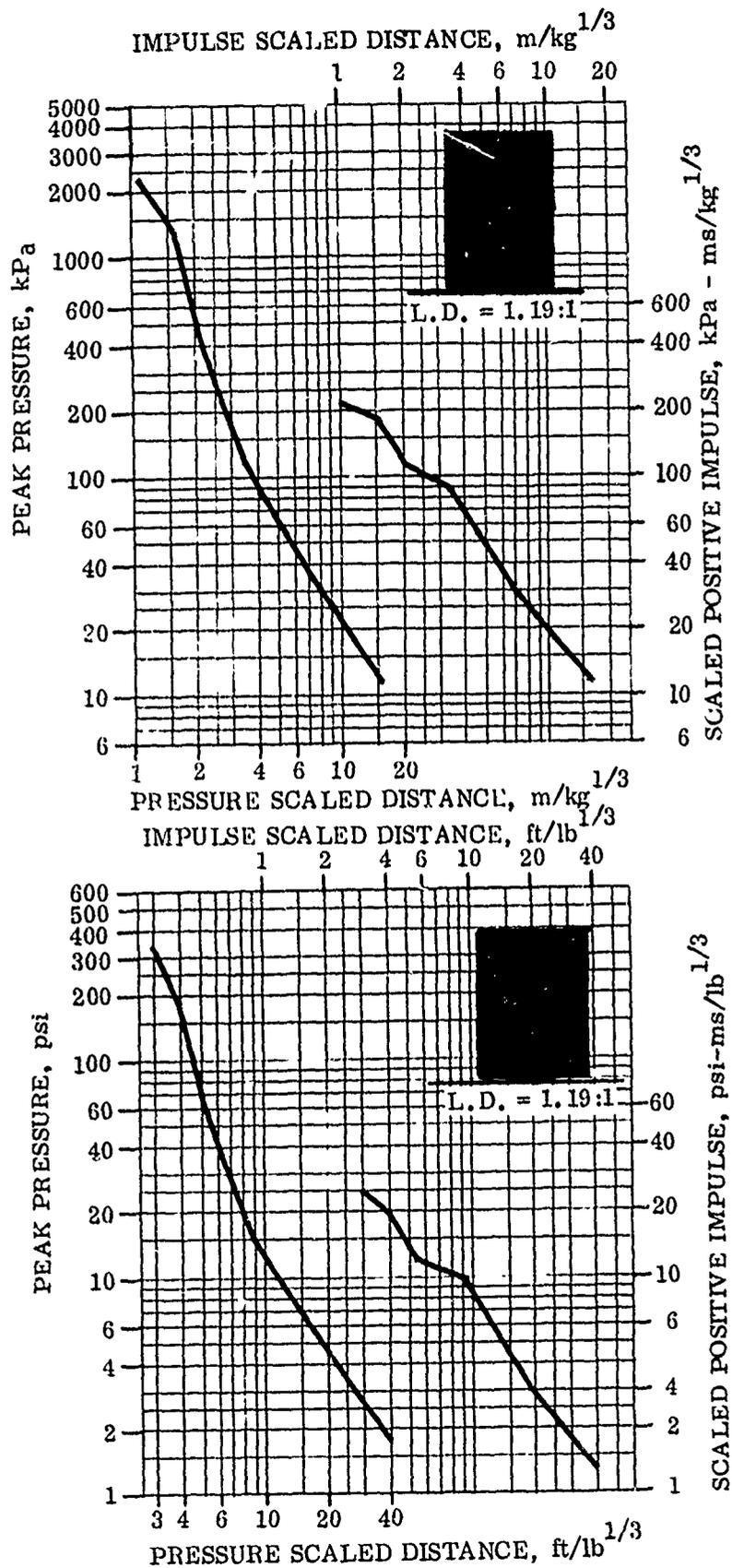
Figure 5.   Pressure and impulse versus scaled distance for 22.68 kg
(50 lb) charge simulated shipping drum scaled

PRESSURE SCALED DISTANCE, ft/lb$^{1/3}$

PRESSURE SCALED DISTANCE, m/kg$^{1/3}$

IMPULSE SCALED DISTANCE, ft/lb$^{1/3}$

IMPULSE SCALED DISTANCE, m/kg$^{1/3}$
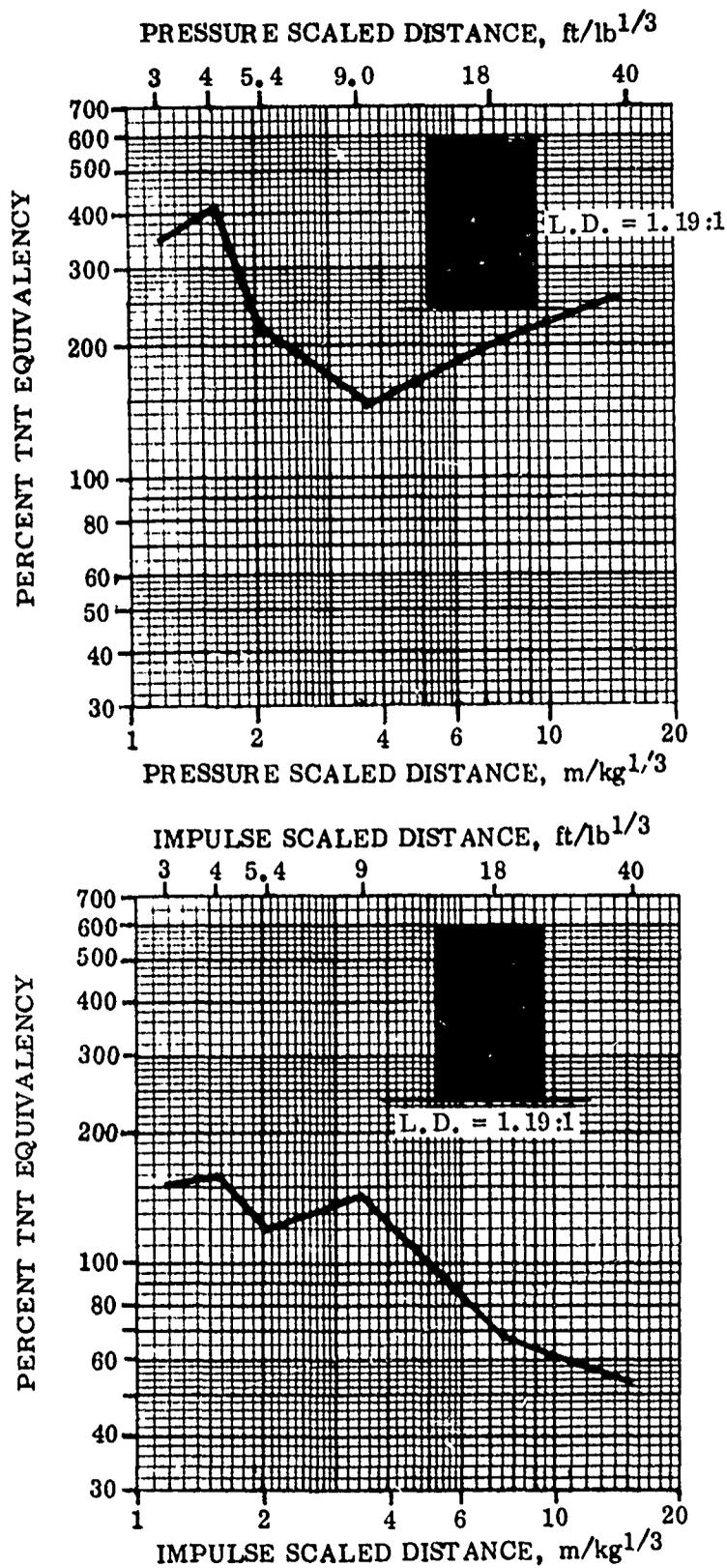
Figure 6. Pressure and impulse equivalencies for the 22.68 kg
(50 lb) charge simulated shipping drum scaled

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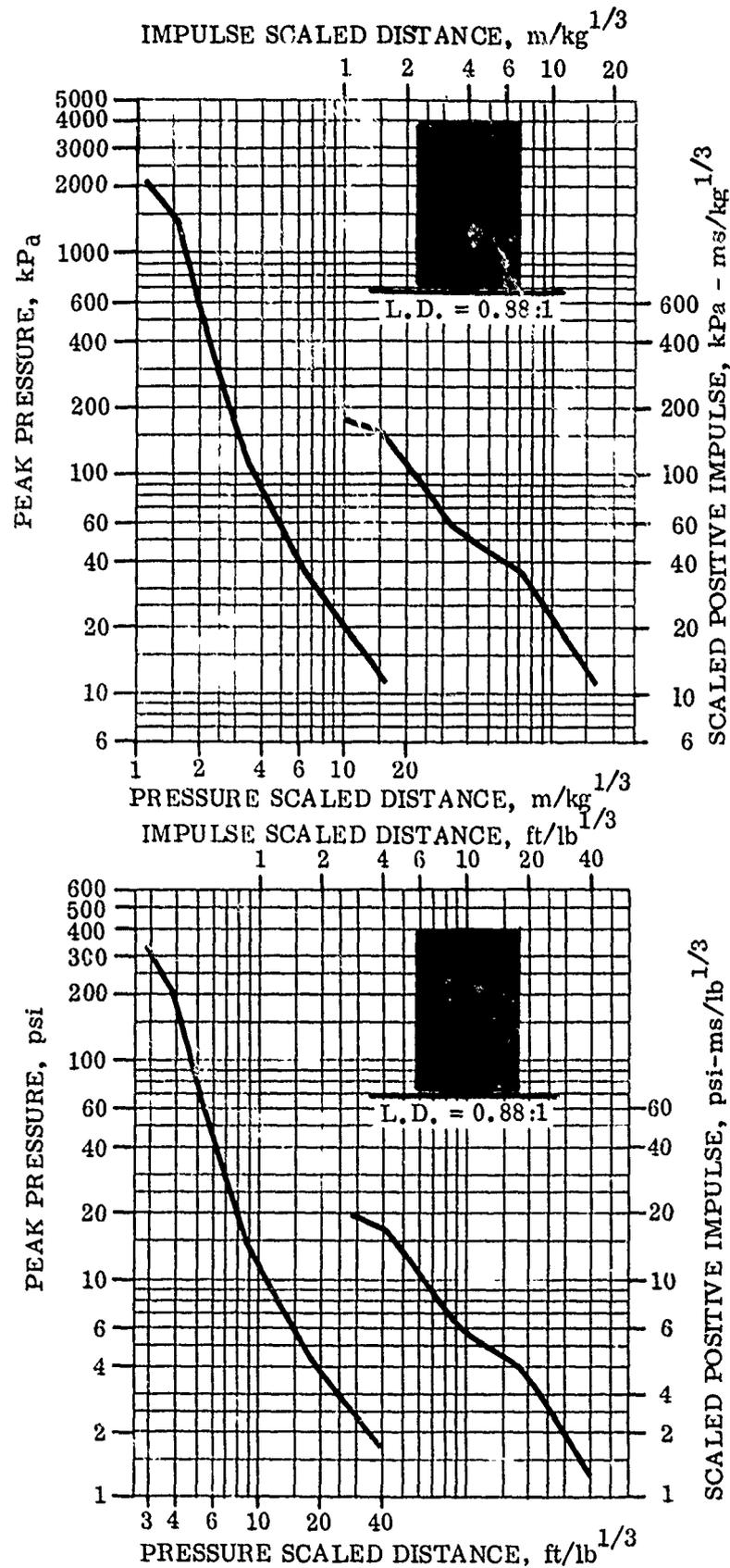
Figure 7. Pressure and impulse versus scaled distance for the 45.36 kg
(100 lb) charge simulated shipping drum scaled

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PRESSURE SCALED DISTANCE, ft/lb$^{1/3}$

PRESSURE SCALED DISTANCE, m/kg$^{1/3}$

IMPULSE SCALED DISTANCE, ft/lb$^{1/3}$

IMPULSE SCALED DISTANCE, m/kg$^{1/3}$
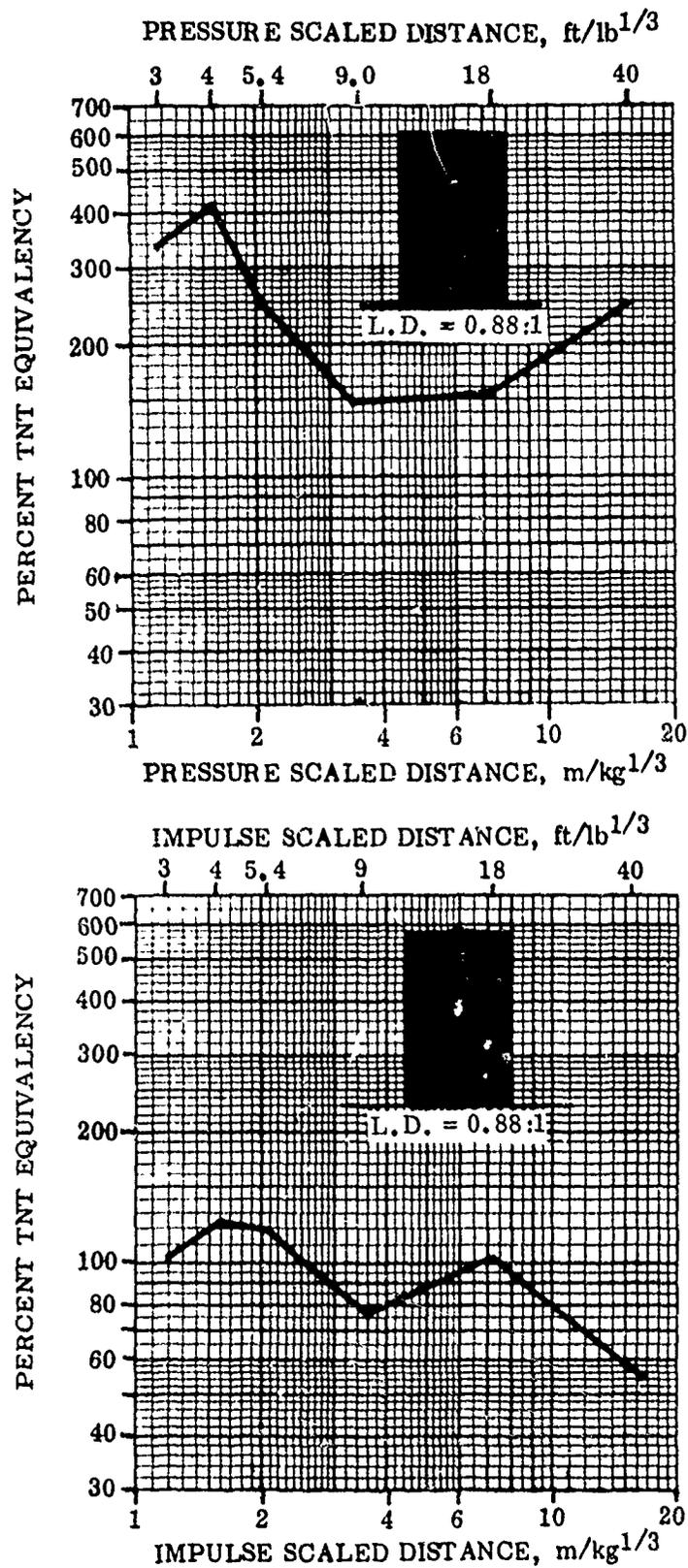
Figure 8. Pressure and impulse equivalencies for the 45.36 kg
(100 lb) charge simulated shipping drum scaled

22
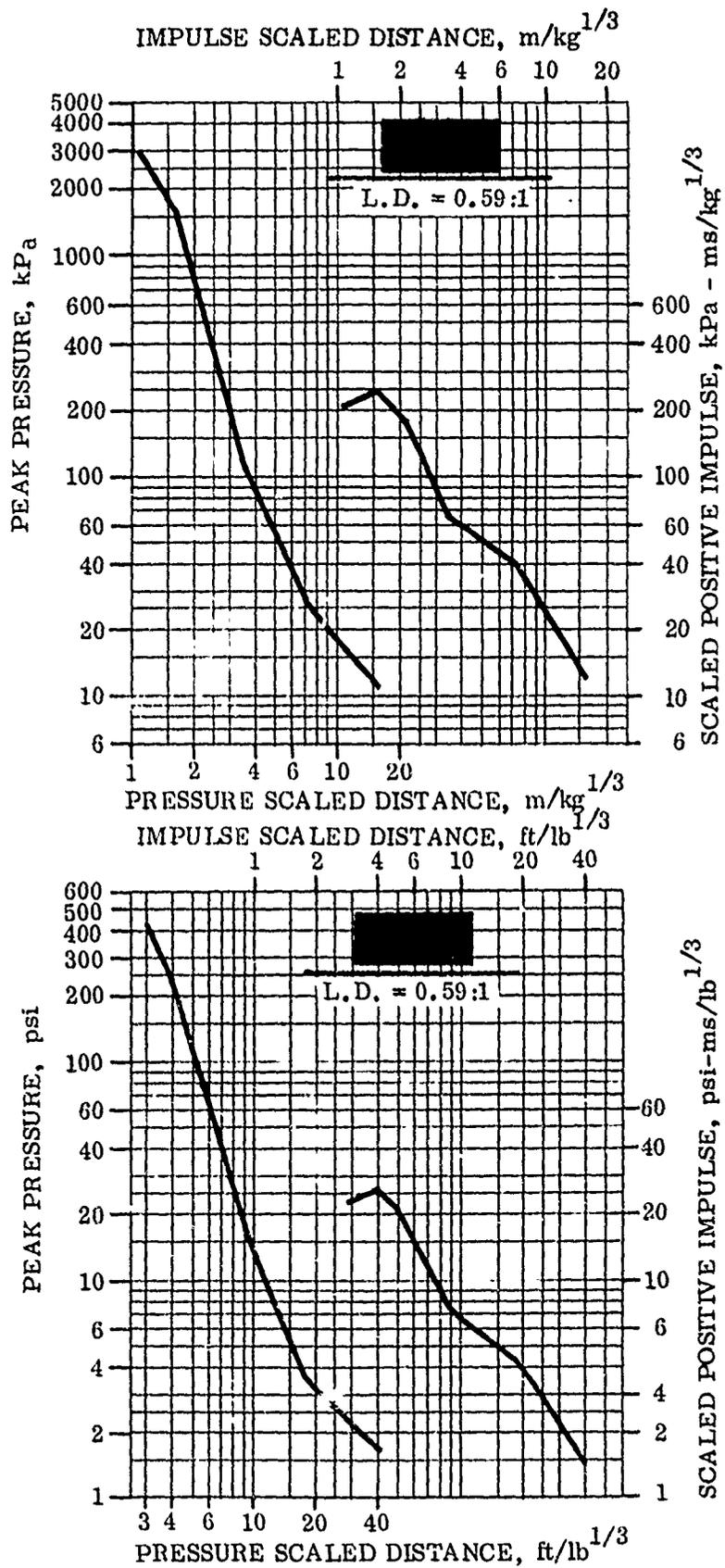
Figure 9. Pressure and impulse versus scaled distance for 27.22 kg
(60 lb) charge simulated Nutsche container scaled

23
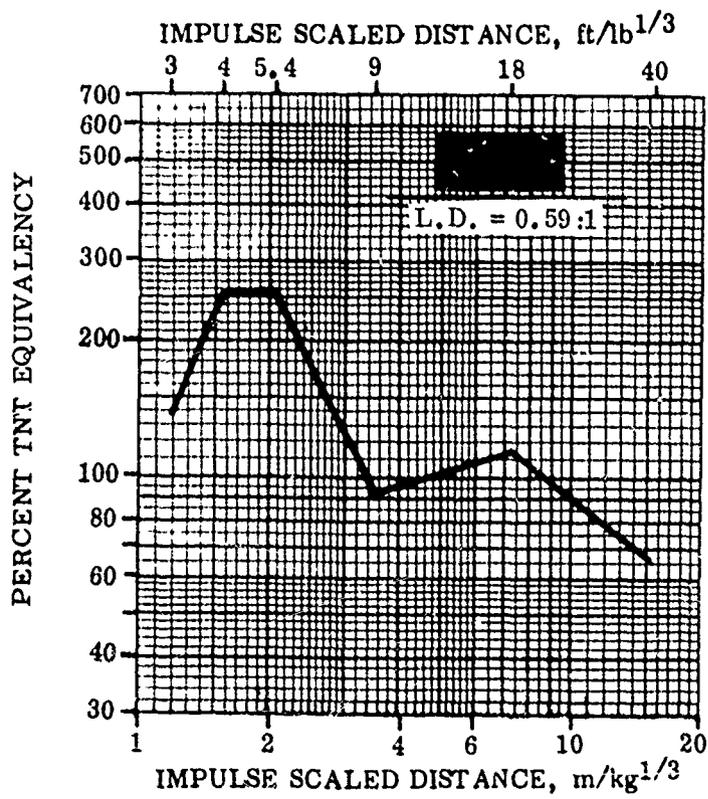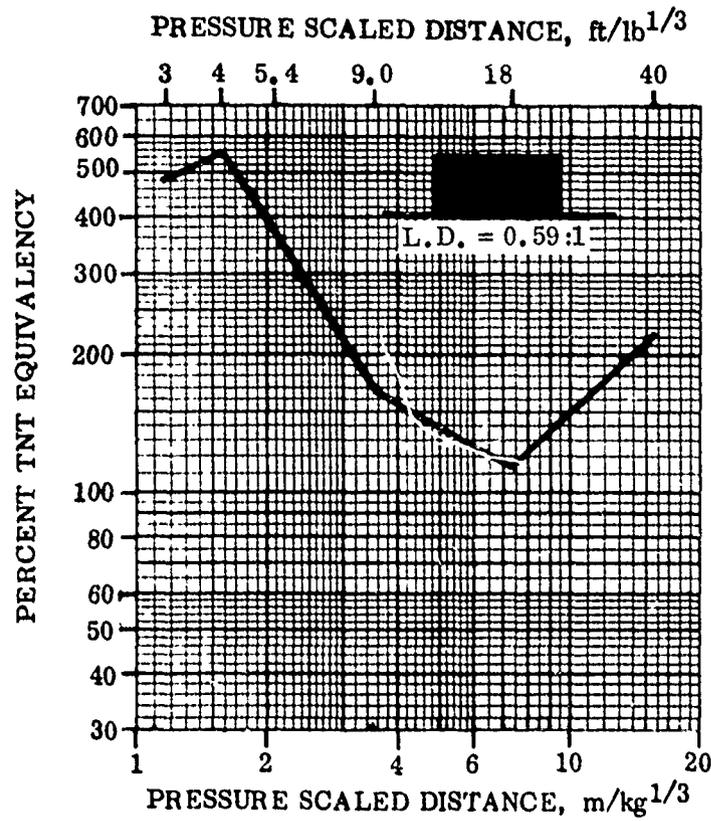
Figure 10. Pressure and impulse equivalencies for the 27.22 kg
(60 lb) charge simulated Nutsche container scaled
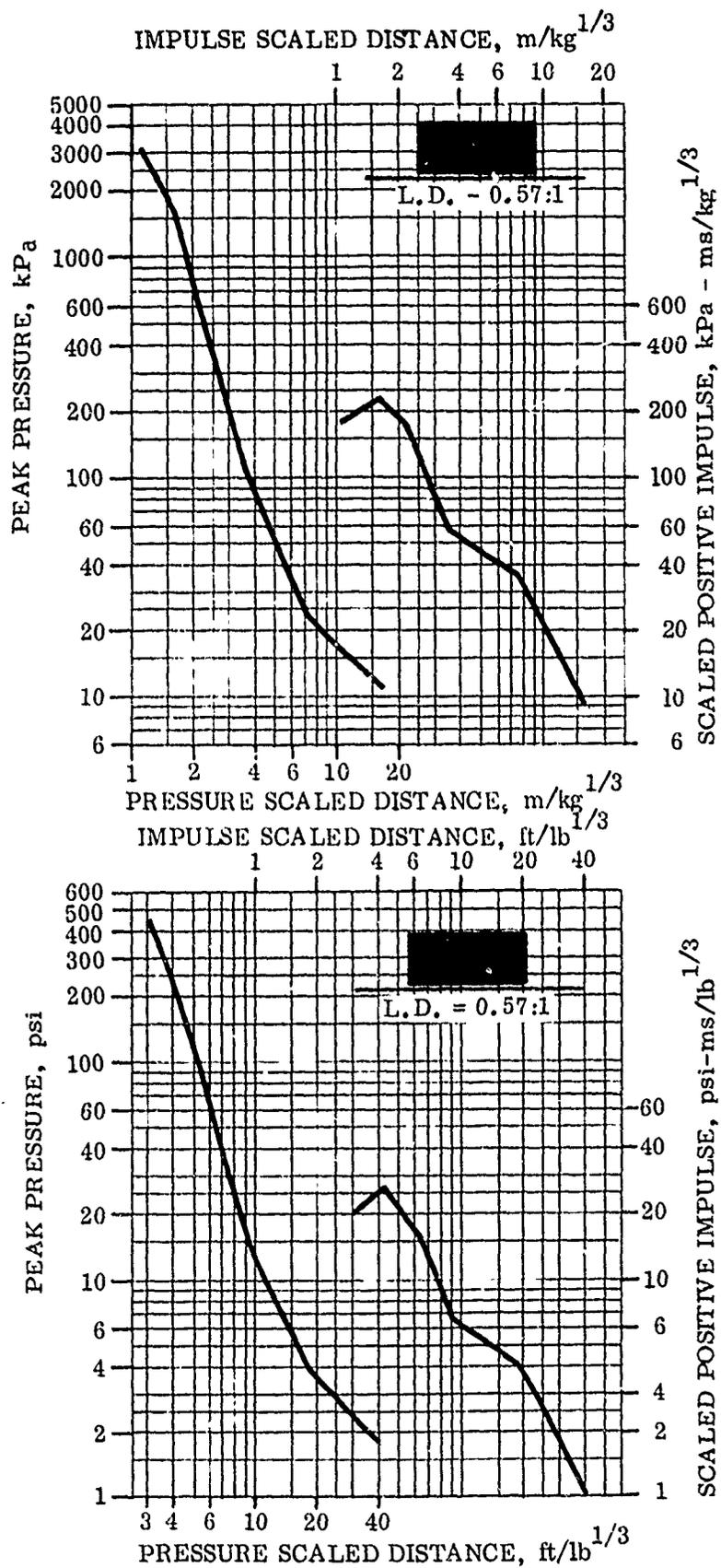
Figure 11. Pressure and impulse versus scaled distance for 54.43 kg
(120 lb) charge simulated Nutsche container scaled
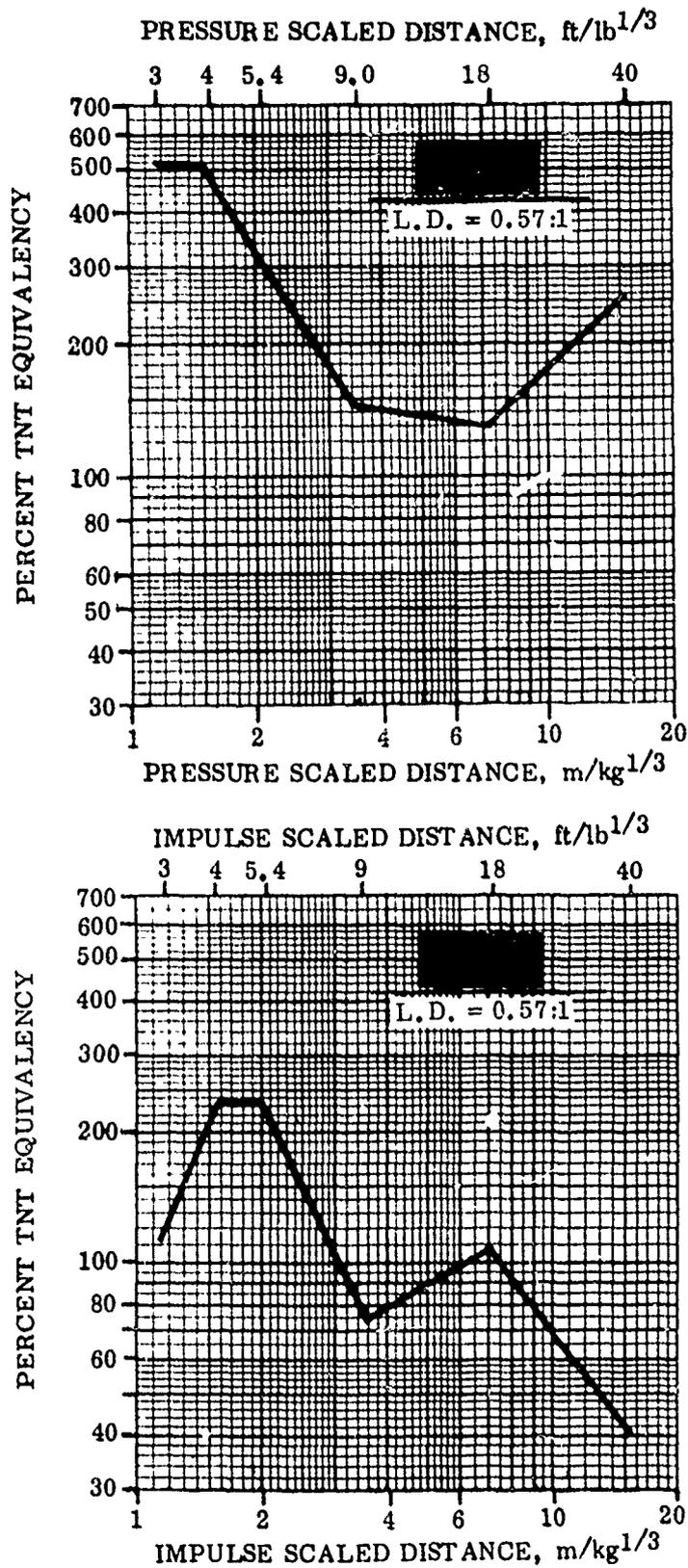
Figure 12. Pressure and impulse equivalencies for the 54.43 kg (120 lb) charge simulated Nutsche container scaled

26
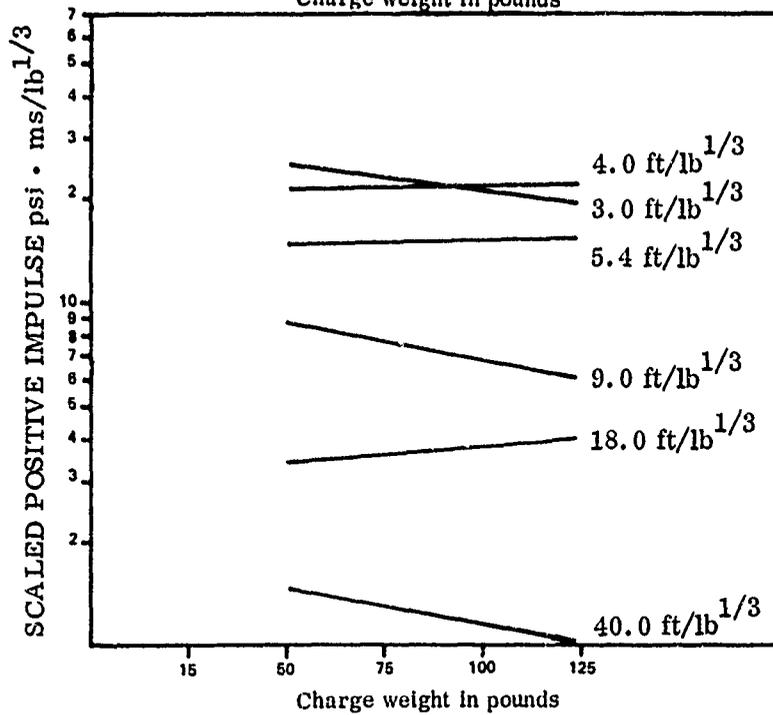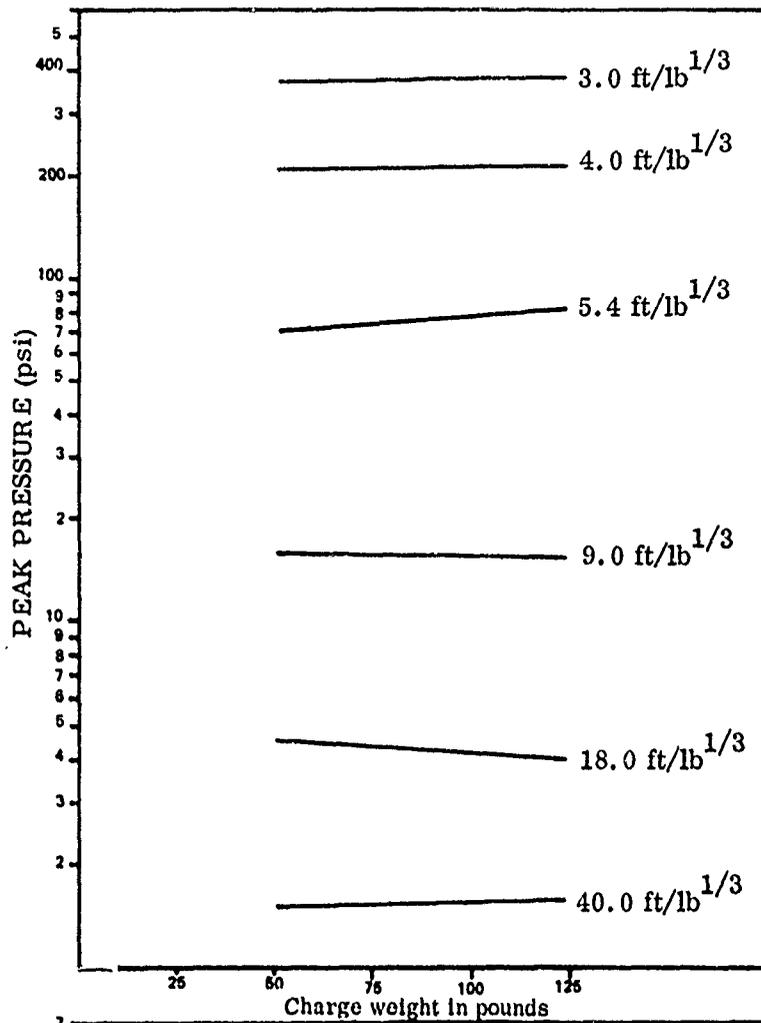
Figure 13. Deviation from cube root scaling

27

Table 6. Fireball diameter and duration

Charge Weight kg (lb)	Maximum Fireball Diameter meters (ft)	Fireball Duration msec
22.68 kg (50 lb) Simulated shipping drum	13.1 m (43 ft)	102
45.36 kg (100 lb) Simulated shipping drum	22.9 m (75 ft)	97
27.22 kg (60 lb) Simulated Nutsche container	21.3 m (70 ft)	170
54.43 kg (120 lb) Simulated Nutsche container	25.9 m (85 ft)	232

for pressure and impulse. Specifically, TNT hemispherical data scales as a slope of one at all charge weights. An increase in pressure with increasing charge weights will be indicated by a positive slope. A decrease in pressure with increasing charge weights is indicated by a negative slope. Generally, an explosive can be said to scale as a function of the cube root of the charge weight when the slope of the line is no greater than 1.000 ($\pm$ 0.001) from the mean. To within experimental error limits of the tests, RDX explosive scales as a function of the cube root of the charge weights.

CONCLUSIONS

(1) RDX, when detonated, can generate peak pressure and positive impulse values which are greater than those produced from an equivalent weight of TNT.

(2) The blast output from RDX is dependent upon the configuration from which it detonates.

(3) TNT equivalency values were determined for RDX in two configurations that simulate in-plant processing and shipping containers.

(4) To within experimental limits, blast pressure and impulse scale as a cube root function of the charge weight.

RECOMMENDATIONS

In order to design meaningful experiments and for the resulting data to be intelligently applied, it is important that the many factors and parameters that affect the airblast be recognized, and that the data be used in the context in which they were derived.

REFERENCES

1. McIntyre, F. L., TNT Equivalency of Composition C-4 in shipping and Process Containers, Feb 81 ARLCD-CR-80061.

2. McIntyre, F. L., TNT Equivalency of Composition A3, Dec 1981 ARLCD-CR-81044.

3. Wisotski, John and Snyer, W. H., Characteristics of Blast Waves Obtained from Cylindrical High Explosive Charges, Denver Research Institute, November 1965.

4. Tancreto, J. E., TNT Equivalencies of RDX Slurry and Various Geometries of Composition B, Preliminary Report, Picatinny Arsenal, Dover, NJ, May 1975.

5. Kingery, C. N., Airblast Parameters Versus Distance for Hemispherical TNT Surface Bursts, BRL Report No. 1344, September 1966.

6. McKown, G. L., TNT Equivalency of R284 Tracer Composition, I559, Igniter Mix, and I560 Subigniter Mix, ARLCD-TR-79026, Picatinny Arsenal, Aug 1979.

APPENDIX A

TEST DATA SHEETS

TEST TITLE __TNT EQUIVALENCY__   DATE __6 Mar 80__
TEST SAMPLE __RDX (98/2)__   TIME __1309__
SAMPLE WEIGHT __22.68 kg__ (50 lb)   TEMP. __18.9°C (66°F)__
IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __60%__
BOOSTER WT. __0.4536 kg__ (1.0 lb)   BAR. PRESS. __30.12__
TEST NO. __10-80-C1__   WIND DIR. __150__
CONTRACT NO. __NAS13-50__   WIND VEL. __0 knots__
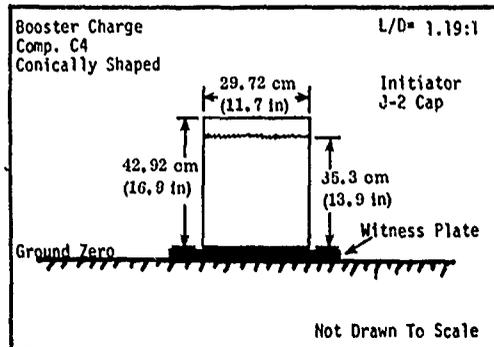
Booster Charge Comp. C4 Conically Shaped — L/D = 1.19:1
Initiator J-2 Cap
29.72 cm (11.7 in)
42.92 cm (16.9 in)
35.3 cm (13.9 in)
Ground Zero — Witness Plate
Not Drawn To Scale

FIELD EVALUATION: Detonation occurred, no unreacted explosive. Crater size 50.8 cm by 233.7 cm (1 ft 8 in x 7 ft 8 in)

Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	3.37	2275 (329.87)	216.03 (24.07)	1.6
2	(11.05)	-	-	-
3	4.49	998 (144.76)	173.8 (19.37)	2.6
4	(14.74)	-	-	-
5	6.06	433 (62.75)	121.3 (13.52)	4.7
6	(19.89)	511 (74.15)	130.4 (14.53)	4.7
7	10.11	115 (16.64)	96.3 (10.73)	12.0
8	(33.16)	129 (18.67)	95.4 (10.63)	12.0
9	20.21	39 (5.67)	14.6 (1.63)	36.5
10	(66.31)	31 (4.524)	43.8 (4.88)	36.7
11	44.92	15 (2.11)	11.7 (1.30)	105.7
12	(147.36)	10 (1.44)	12.0 (1.34)	106.5

TEST TITLE __TNT EQUIVALENCY__   DATE __6 Mar 80__
TEST SAMPLE __RDX (98/2)__   TIME __1351__
SAMPLE WEIGHT __22.68 kg__ (50 lb)   TEMP. __19.4°C (67°F)__
IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __60%__
BOOSTER WT. __0.4536 kg__ (1.0 lb)   BAR. PRESS. __30.11__
TEST NO. __10-80-C2__   WIND DIR. __153__
CONTRACT NO. __NAS13-50__   WIND VEL. __0-2 knots__

Booster Charge Comp. C4 Conically Shaped — L/D = 1.19:1
Initiator J-2 Cap
29.72 cm (11.7 in)
42.92 cm (16.9 in)
35.3 cm (13.9 in)
Ground Zero — Witness Plate
Not Drawn To Scale
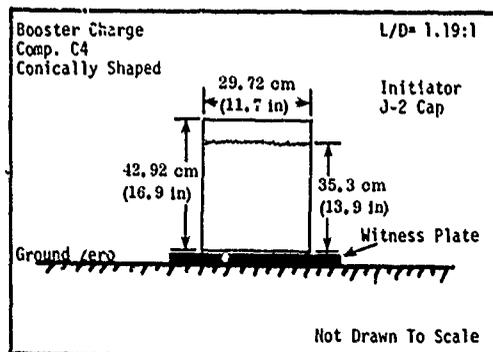
FIELD EVALUATION: Detonation occurred, no unreacted explosive. Crater size 53.3 cm by 233.7 cm (1 ft 9 in x 7 ft 8 in)

Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	3.37	2298 (333.20)	268 (29.86)	2.9
2	(11.05)	1960 (284.26)	152 (16.94)	2.8
3	4.49	962 (139.50)	184.5 (20.56)	3.7
4	(14.74)	1896 (275.00)	145 (16.16)	3.6
5	6.06	529 (76.69)	121.8 (13.57)	5.7
6	(19.89)	289 (41.91)	108.7 (12.11)	5.9
7	10.11	95 (13.73)	88.6 (9.87)	13.5
8	(33.16)	126 (18.30)	95.7 (10.66)	13.5
9	20.21	40 (5.73)	15.5 (1.73)	37.8
10	(66.31)	33 (4.84)	42.4 (4.72)	37.8
11	44.92	15 (2.11)	12.1 (1.35)	102.7
12	(147.36)	9 (1.35)	11.0 (1.23)	103.8

TEST TITLE: __TNT Equivalency__   DATE __6 Mar 80__

TEST SAMPLE __RDX (98/2)__   TIME __1432__

SAMPLE WEIGHT __22.68 kg__ (__50__ lb)   TEMP. __20°C (68°F)__

IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __61%__

BOOSTER WT. __0.4536 kg__ (__1.0__ lb)   BAR. PRESS. __30.10__

TEST NO. __10-80-C3__   WIND DIR. __200__

CONTRACT NO. __NAS13-50__   WIND VEL. __0-2 knots__
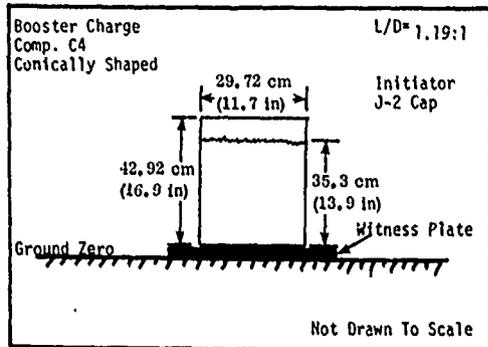
Booster Charge Comp. C4 Conically Shaped   L/D= 1.19:1
29.72 cm (11.7 in)   Initiator J-2 Cap
42.92 cm (16.9 in)   35.3 cm (13.9 in)
Ground Zero   Witness Plate
Not Drawn To Scale

FIELD EVALUATION: Detonation occurred, no unreacted explosive. Crater size 50.8 cm by 233.7 cm (1 ft 8 in x 7 ft 8 in)

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	3.37	2298 (333.2)	277.8 (30.96)	1.5
2	(11.05)	2614 (379.01)	237.7 (26.48)	1.4
3	4.49	1670 (242.14)	203.3 22.65	2.2
4	(14.74)	1224 (177.5)	-	2.2
5	6.06	409 (59.26)	116.1 (12.94)	4.2
6	(19.89)	389 (56.42)	115.8 (12.90)	4.0
7	10.11	92 (13.31)	74.6 (8.31)	12.0
8	(33.16)	91 (13.18)	70.0 (7.80)	11.5
9	20.21	38 (5.51)	15.8 (1.76)	36.7
10	(66.31)	29 (4.21)	37.4 (4.17)	36.4
11	44.92	15 (2.24)	12.0 (1.34)	101.7
12	(147.36)	9 (1.26)	4.8 (.53)	102.3

TEST TITLE: __TNT EQUIVALENCY__   DATE __7 Mar 80__

TEST SAMPLE __RDX (98/2)__   TIME __1315__

SAMPLE WEIGHT __27.22 kg__ (__60__ lb)   TEMP. __22.8°C (73°F)__

IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __82%__

BOOSTER WT. __0.544 kg__ (__1.2__ lb)   BAR. PRESS. __30.10__

TEST NO. __10-80-C4__   WIND DIR. __160__

CONTRACT NO. __NAS13-50__   WIND VEL. __2-8 knots__

Booster Charge Comp. C4 Conically Shaped   L/D= 0.59:1
30.0 cm (11.8 in)   Initiator J-2 Cap
22.8 cm (9.0 in)   17.8 cm (7.0 in)   WITNESS PLATE
Ground Zero
Not Drawn To Scale
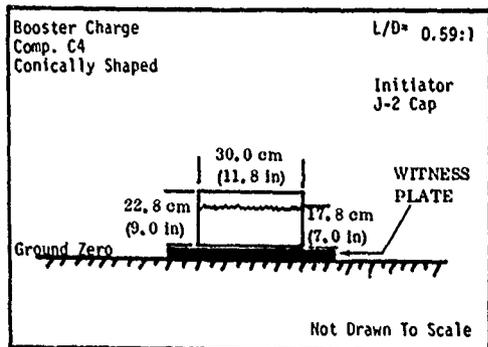
FIELD EVALUATION: Detonation occurred, no unreacted explosive, 63.5 cm by 256.5 cm (2 ft 1 in x 8 ft 5 in) Crater size

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	3.58	3150.7 (456.96)	203.5 (22.67)	1.3
2	(11.745)	3102.8 (450.0)	220.6 (24.58)	1.0
3	4.77	1483 (215.0)	209.6 (23.35)	2.0
4	(15.66)	1946. (282.24)	224.6 (25.02)	1.8
5	6.44	603 (87.5)	150.1 (16.72)	4.0
6	(21.14)	628 (91.08)	-	-
7	10.74	97 (14.04)	52.7 (5.87)	12.3
8	(35.234)	145 (21.06)	82.4 (9.18)	10.7
9	21.48	25 (3.59)	30 (3.34)	39.0
10	(70.468)	28 (4.08)	29.8 (3.32)	37.0
11	47.73	14.56 (2.112)	7.8 (0.87)	108.5
12	(156.595)	10 (1.38)	20.0 (2.23)	107.2

TEST TITLE __TNT Equivalency__   DATE __7 Mar 80__

TEST SAMPLE __RDX (98/2)__   TIME __1405__

SAMPLE WEIGHT __27.22 kg__ (__60__ lb)   TEMP. __22.8°C (73°F)__

IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __77%__

BOOSTER WT. __0.544 kg__ (__1.2__ lb)   BAR. PRESS. __30.10__

TEST NO. __10-80-C5__   WIND DIR. __160__

CONTRACT NO. __NAS13-50__   WIND VEL. __10-18 knots__

Booster Charge
Comp. C4
Conically Shaped   L/D= 0.59:1

Initiator J-2 Cap

30.0 cm (11.8 in)

22.8 cm (9.0 in)   17.8 cm (7.0 in)   Witness Plate

Ground Zero

Not Drawn To Scale
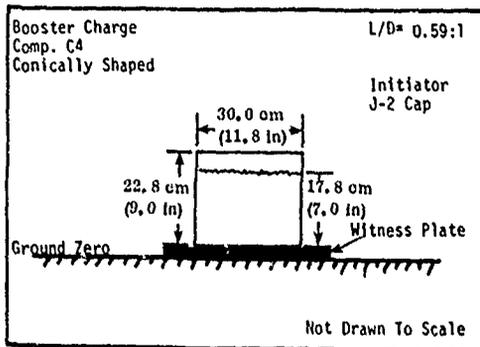
FIELD EVALUATION: __Detonation occurred, no unreacted__

__explosive. Crater size 73.7 in x 24.6 cm (2 ft 5 in x 8 ft 1 in)__

Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	3.58	2954 (428.4)	223.4 (24.89)	1.9
2	(11.745)	3413 (495.00)	-	2.0
3	4.77	1552 (225.00)	199.8 (22.26)	2.6
4	(15.66)	1825 (264.60)	247.5 (27.58)	2.6
5	6.44	543 (78.75)	151.0 (16.83)	4.6
6	(21.14)	728 (105.60)	232.1 (25.86)	4.6
7	10.74	116 (16.85)	43.0 (4.79)	12.8
8	(35.234)	132 (19.19)	76.5 (8.52)	11.9
9	21.48	24 (3.45)	48.0 (5.35)	39.1
10	(70.468)	29 (4.22)	46.4 (5.17)	37.8
11	47.73	14.5 (2.112)	7.6 (0.85)	109.1
12	(156.595)	8 (1.17)	18.8 (2.09)	107.9

TEST TITLE __TNT Equivalency__   DATE __7 Mar 80__

TEST SAMPLE __RDX (98/2)__   TIME __1538__

SAMPLE WEIGHT __27.22 kg__ (__60__ lb)   TEMP. __23.3°C (74°F)__

IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __80%__

BOOSTER WT. __0.544 kg__ (__1.2__ lb)   BAR. PRESS. __30.10__

TEST NO. __10-80-C6__   WIND DIR. __180__

CONTRACT NO. __NAS13-50__   WIND VEL. __3-12 knots__

Booster Charge
Comp. C4
Conically Shaped   L/D= 0.59:1

Initiator J-2 Cap

30.0 cm (11.8 in)

22.8 cm (9.0 in)   17.8 cm (7.0 in)   WITNESS PLATE

Ground Zero

Not Drawn To Scale
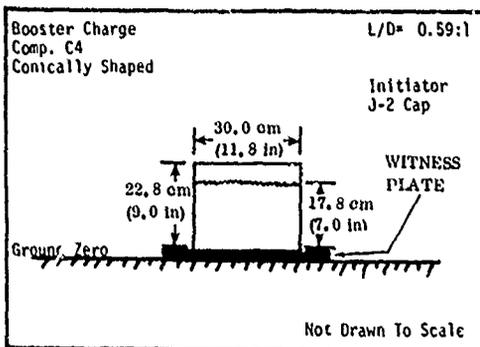
FIELD EVALUATION: __Detonation occurred, no unreacted__

__explosive. Crater size 66.0 cm x 248.9 cm (2 ft 2 in x 8 ft 2 in)__

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	3.58	2954 (428.40)	209.3 (23.32)	1.3
2	(11.745)	2069 (300.00)	175.0 (19.50)	1.4
3	4.77	1103 (160.00)	149.9 (16.71)	2.1
4	(15.66)	2027 (294.00)	369.7 (41.19)	2.2
5	6.44	560 (81.25)	161.6 (18.01)	4.0
6	(21.14)	801 (116.16)	236.9 (26.40)	3.5
7	10.74	87 (12.64)	-	12.3
8	(35.234)	136 (19.66)	77.1 (8.59)	10.5
9	21.48	24 (3.45)	45.0 (5.02)	39.5
10	(70.468)	24 (3.54)	42.5 (4.73)	37.3
11	47.73	12 (1.72)	10.9 (1.21)	109.4
12	(156.595)	9.5 (1.378)	-	107.8

TEST TITLE __TNT Equivalency__   DATE __8 Mar 80__
TEST SAMPLE __RDX (98/2)__   TIME __0901__
SAMPLE WEIGHT __45.36 kg__ (__100__ lb)   TEMP. __25°C (77°F)__
IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __54%__
BOOSTER WT. __0.907 kg__ (__2.0__ lb)   BAR. PRESS. __29.94__
TEST NO. __10-80-C7__   WIND DIR. __345__
CONTRACT NO. __NAS13-50__   WIND VEL. __0-1 knots__

```
Booster Charge                    L/D= 0.88:1
Comp. C4
Conically Shaped
        37.3 cm            Initiator
       (14.7 in)           J-2 Cap
  53.34 cm         33.0 cm
  (21.0 in)        (13.0 in)
                          Witness Plate
Ground Zero
                          Not Drawn To Scale
```
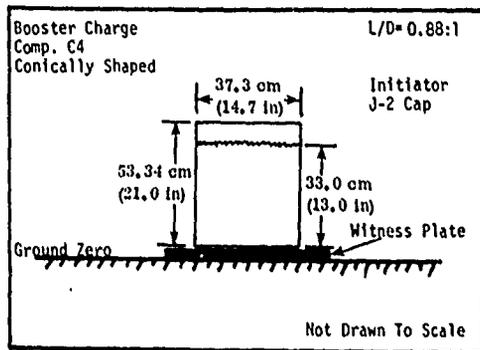
FIELD EVALUATION: Detonation occurred, no unreacted

explosive. Crater size 76.2 cm x 335.3 cm (2 ft 6 in x 11 ft 0 in)

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	4.24	2069 (300.00)	171.1 (19.06)	2.6
2	(13.92)	2534 (367.5)	173.7 (19.35)	2.8
3	5.66	1451 (210.4)	153.6 (17.11)	3.5
4	(18.57)	1668 (241.96)	143.4 (15.98)	3.6
5	7.64	559 (81.00)	-	5.0
6	(25.06)	420 (60.9)	97.0 (10.81)	5.3
7	12.73	-	-	14.8
8	(41.77)	139 (20.12)	75.1 (8.37)	15.0
9	25.47	30 (4.40)	51.3 (5.72)	46.1
10	(83.55)	31.4 (4.557)	38.0 (4.23)	46.1
11	56.59	11.2 (1.625)	10.1 (1.12)	128.2
12	(185.66)	14.4 (2.09)	-	129.0

TEST TITLE __TNT Equivalency__   DATE __8 Mar 80__
TEST SAMPLE __RDX (98/2)__   TIME __1003__
SAMPLE WEIGHT __45.36 kg__ (__100__ lb)   TEMP. __26.7°C (80°F)__
IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __54%__
BOOSTER WT. __0.907 kg__ (__2.0__ lb)   BAR. PRESS. __29.94__
TEST NO. __10-80-C8__   WIND DIR. __025__
CONTRACT NO. __NAS13-50__   WIND VEL. __0-1 knots__

```
Booster Charge                    L/D= 0.88:1
Comp. C4
Conically Shaped
        37.3 cm            Initiator
       (14.7 in)           J-2 Cap
  53.34 cm         33.0 cm
  (21.0 in)        (13.0 in)
                          Witness Plate
Ground Zero
                          Not Drawn To Scale
```
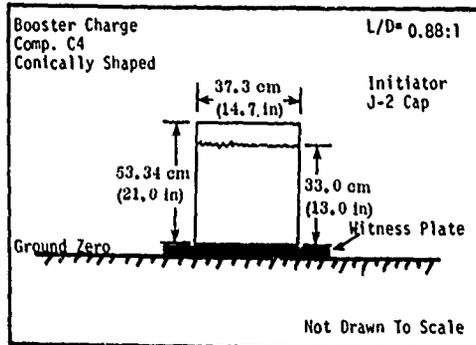
FIELD EVALUATION. Detonation occurred, no unreacted

explosive. Crater size 78.7 cm x 325.1 cm (2 ft 7 in x 10 ft 8 in)

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	4.24	1903 (276.00)	195.2 (21.75)	2.4
2	(13.92)	2327 (337.50)	206.8 (23.04)	2.4
3	5.66	1197 (173.58)	162.4 (18.09)	3.2
4	(18.57)	1451 (210.40)	-	3.1
5	7.64	642 (93.15)	129.9 (14.47)	5.7
6	(25.06)	294 (42.63)	103.6 (11.54)	5.6
7	12.73	124 (17.98)	48.3 (5.38)	5.8
8	(41.77)	97 (14.12)	-	5.2
9	25.47	27 (3.976)	43.8 (4.88)	46.0
10	(83.55)	36 (5.25)	34.8 (3.88)	47.4
11	56.59	10.3 (1.50)	7.0 (0.78)	128.0
12	(185.66)	12 (1.74)	15.7 (1.75)	130.1

Top Form

TEST TITLE __TNT Equivalency__ DATE __8 Mar 80__

TEST SAMPLE __RDX (98/2)__ TIME __1044__

SAMPLE WEIGHT __45.36 kg__ (100 lb) TEMP. __27.2°C (81°F)__

IGN. SOURCE __J2 Blasting Cap__ HUMIDITY __53%__

BOOSTER WT. __0.907 kg__ (2.0 lb) BAR. PRESS. __29.94__

TEST NO. __10-80-C9__ WIND DIR. __033__

CONTRACT NO. __NAS13-50__ WIND VEL. __0-1 knots__

Booster Charge Comp. C4 Conically Shaped L/D= 0.88:1

37.3 cm (14.7 in) Initiator J-2 Cap

53.34 cm (21.0 in) 33.0 cm (13.0 in)

Ground Zero Witness Plate

Not Drawn To Scale
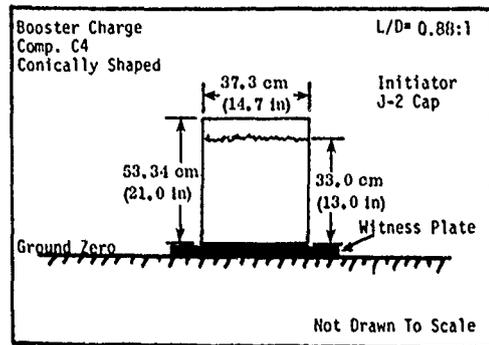
FIELD EVALUATION· Detonation occurred, no unreacted explosive. Crater size 66.0 cm x 284.5 cm (2 ft 2 in x 9 ft 4 in)

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	4.24	2482 (360.0)	158.7 (17.68)	2.9
2	(13.92)	1810 (262.5)	140 (15.60)	2.8
3	5.66	1306 (189.36)	154.6 (17.23)	3.9
4	(18.57)	1269 (184.1)	168.4 (18.76)	3.6
5	7.64	633 (91.8)	137.9 (15.37)	5.7
6	(25.06)	294 (42.63)	122.6 (13.66)	5.6
7	12.73	133 (19.26)	47.1 (5.25)	6.6
8	(41.77)	92 (13.27)	-	8.0
9	25.47	29 (4.26)	22.3 (2.49)	46.7
10	(83.55)	28 (4.12)	33.8 (3.77)	47.2
11	56.59	13 (1.83)	14.2 (1.58)	128.5
12	(185.66)	12 (1.74)	11.5 (1.28)	129.5

Bottom Form

TEST TITLE __TNT Equivalency__ DATE __8 Mar 80__

TEST SAMPLE __RDX (98/2)__ TIME __1229__

SAMPLE WEIGHT __54.43 kg__ (120 lb) TEMP. __27.8°C (82°F)__

IGN. SOURCE __J2 Blasting Cap__ HUMIDITY __52%__

BOOSTER WT. __1.088 kg__ (2.4 lb) BAR. PRESS. __29.93__

TEST NO. __10-80-C10__ WIND DIR. __140__

CONTRACT NO. __NAS13-50__ WIND VEL. __0-1 knots__

Booster Charge Comp. C4 Conically Shaped L/D= 0.57:1

37.6 cm (14.8 in) Initiator J-2 Cap

27.9 cm (11.0 in) 21.6 cm (8.5 in) WITNESS PLATE

Ground Zero

Not Drawn To Scale
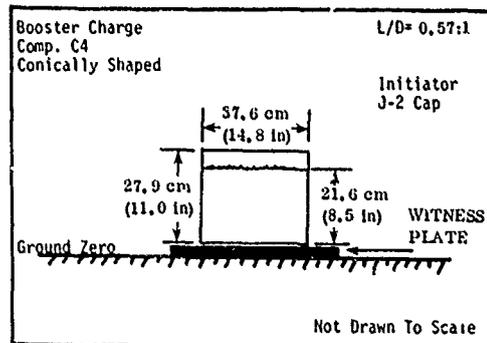
FIELD EVALUATION· Detonation occurred, no unreacted explosive. Crater size 73.7 cm x 320.0 cm (2 ft 5 in x 10 ft 6 in)

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	4.51	2854.8 (414.00)	188.6 (21.01)	2.4
2	(14.80)	3568 (517.50)	223.4 (24.89)	1.5
3	6.01	1632 (236.70)	219.2 (24.42)	3.9
4	(19.73)	1523 (220.92)	291.8 (32.51)	3.8
5	8.12	623.7 (90.45)	122.3 (13.63)	6.2
6	(26.64)	-	-	-
7	13.53	76.7 (11.13)	51.1 (5.69)	16.4
8	(44.39)	76.7 (11.13)	29.7 (3.31)	14.8
9	27.06	25.4 (3.69)	62.8 (7.00)	50.0
10	(88.78)	31.3 (4.54)	41.6 (4.64)	47.7
11	60.14	14.3 (2.07)	7.1 (0.79)	138.0
12	(197.3)	8.5 (1.23)	16.7 (1.86)	135.8

Test 10-80-C11

TEST TITLE __TNT Equivalency__   DATE __8 Mar 80__

TEST SAMPLE __RDX (98/2)__   TIME __1312__

SAMPLE WEIGHT __54.43 kg__ (120 lb)   TEMP. __27.2°C (81°F)__

IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __50%__

BOOSTER WT. __1.088 kg__ (2.4 lb)   BAR. PRESS. __29.93__

TEST NO. __10-80-C11__   WIND DIR. __110__

CONTRACT NO. __NAS13-50__   WIND VEL. __0-1 knots__

Booster Charge
Comp. C4
Conically Shaped   L/D= 0.57:1

Initiator J-2 Cap

37.6 cm (14.8 in)

27.9 cm (11.0 in)   21.6 cm (8.5 in)   WITNESS PLATE

Ground Zero

Not Drawn To Scale
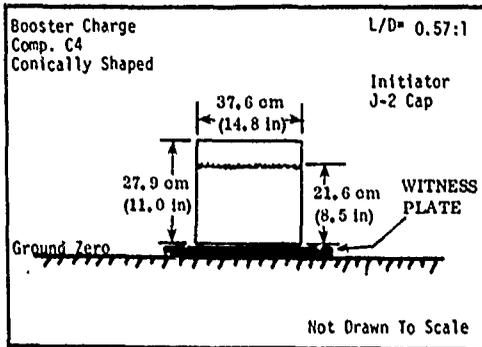
FIELD EVALUATION: Detonation occurred, no unreacted explosive. Crater size 73.7 cm x 312.4 cm (2 ft 5 in x 10 ft 3 in)

| Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	4.51	1862 (270.00)	179 (19.95)	1.2
2	(14.80)	3103 (450.00)	224.8 (25.05)	1.2
3	6.01	1342 (194.62)	162.5 (18.11)	2.0
4	(19.73)	1632 (236.70)	271.3 (30.23)	2.1
5	8.12	614 (89.10)	157 (17.49)	4.3
6	(26.64)	605 (87.70)	193.5 (21.56)	4.2
7	13.53	127 (18.40)	55.6 (6.19)	14.6
8	(44.39)	127 (18.40)	67.0 (7.47)	12.8
9	27.06	22.5 (3.27)	17.2 (1.92)	48.8
10	(88.78)	31.3 (4.54)	35.4 (3.94)	45.9
11	60.14	14.3 (2.07)	6.3 (0.70)	137.4
12	(197.3)	23.5 (3.41)	7.5 (0.84)	133.7

Test 10-80-C12

TEST TITLE __TNT Equivalency__   DATE __8 Mar 80__

TEST SAMPLE __RDX (98/2)__   TIME __1350__

SAMPLE WEIGHT __54.43 kg__ (120 lb)   TEMP. __27.2°C (81°F)__

IGN. SOURCE __J2 Blasting Cap__   HUMIDITY __50%__

BOOSTER WT. __1.088 kg__ (2.4 lb)   BAR. PRESS. __29.92__

TEST NO. __10-80-C12__   WIND DIR. __110__

CONTRACT NO. __NAS13-50__   WIND VEL. __0-1 knots__

Booster Charge
Comp. C4
Conically Shaped   L/D= 0.57:1

Initiator J-2 Cap

37.6 cm (14.8 in)

27.9 cm (11.0 in)   21.6 cm (8.5 in)   WITNESS PLATE

Ground Zero

Not Drawn To Scale
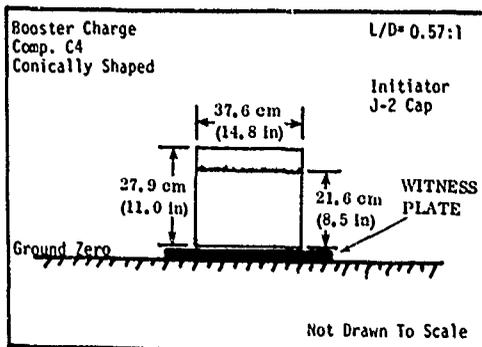
FIELD EVALUATION: Detonation occurred, no unreacted explosive—76.2 cm x 325.1 cm (2 ft 6 in x 10 ft 8 in) Crater size.

Channel Number	Distance Meters (ft)	Peak Pressure kPa (psi)	Scaled Positive Impulse kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	Time of Arrival (msec)
1	4.51	2896 (420.00)	149.1 (16.61)	2.5
2	(14.80)	4086 (592.50)	137.9 (15.37)	2.4
3	6.01	1886 (273.52)	217.3 (24.21)	3.4
4	(19.73)	1632 (236.70)	215.7 (24.03)	3.4
5	8.12	559 (81.00)	114.4 (12.75)	5.7
6	(26.64)	697 (101.09)	229.7 (25.59)	5.3
7	13.53	92 (13.27)	56.6 (6.31)	15.7
8	(44.39)	139 (20.12)	61.4 (6.84)	14.0
9	27.06	25.4 (3.69)	47.2 (5.26)	49.4
10	(88.78)	30.3 (4.40)	20.4 (2.27)	46.9
11	60.14	13.4 (1.95)	6.8 (0.76)	137.4
12	(197.3)	10.1 (1.46)	10.4 (1.16)	134.5

APPENDIX B

SELECTED PHOTOGRAPHS
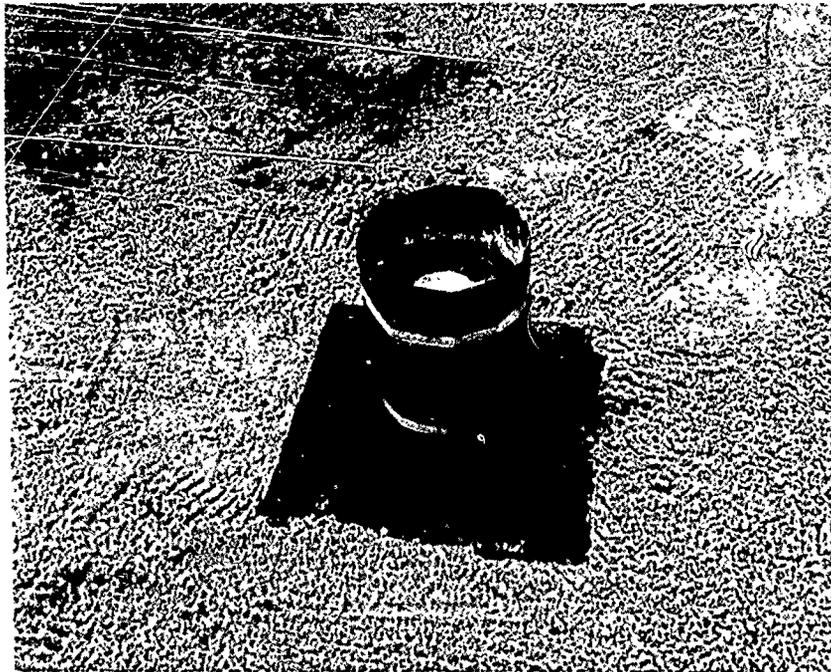
RDX pretest configuration
22.68 kg (50 lb) charge
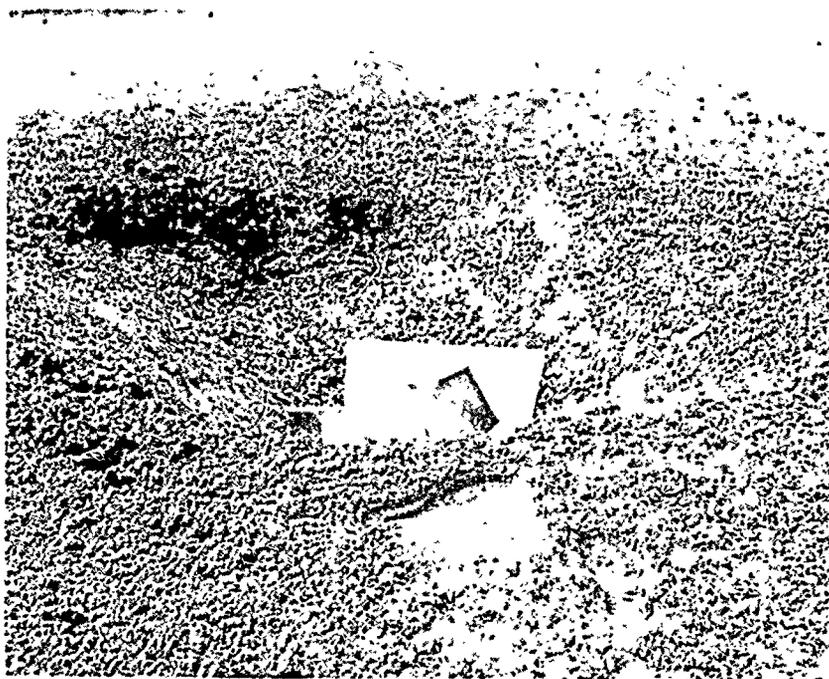
RDX posttest crater
22.68 kg (50 lb) charge

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RDX pretest configuration
45.36 kg (100 lb) charge weight

RDX posttest crater
45.36 kg (100 lb) charge weight
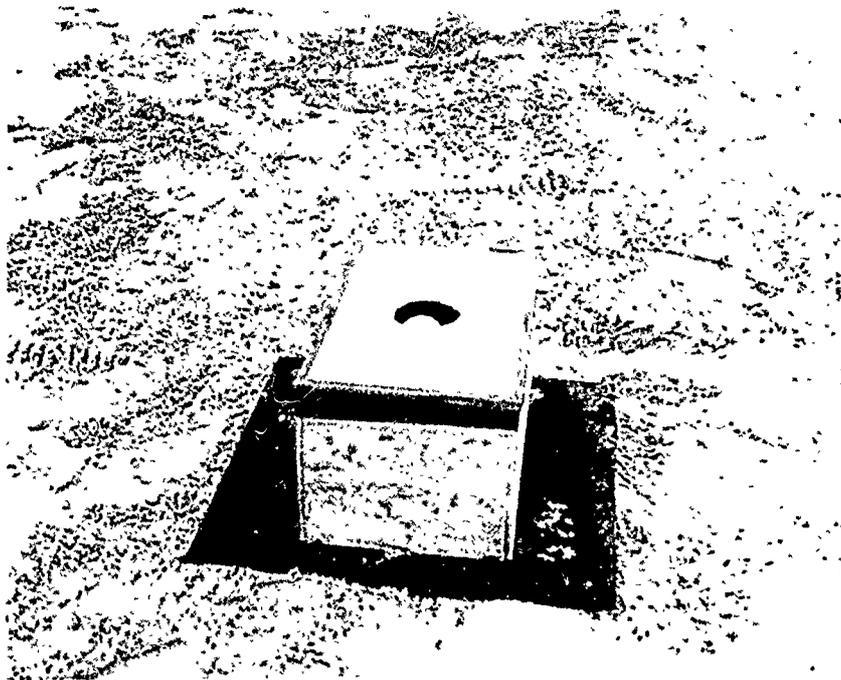
RDX pretest configuration
27.22 kg (60 lb) charge weight
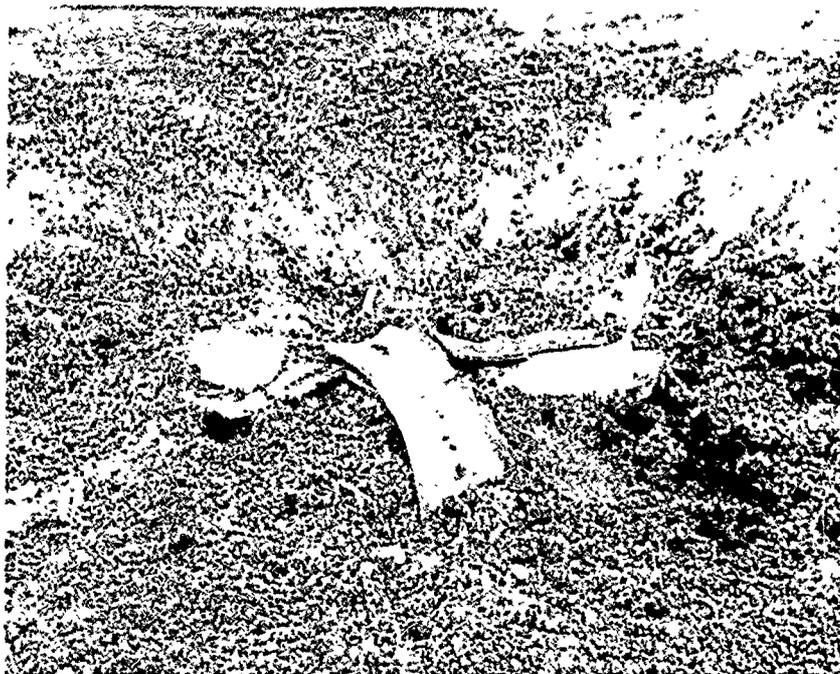
RDX posttest crater
27.22 kg (60 lb) charge weight

43
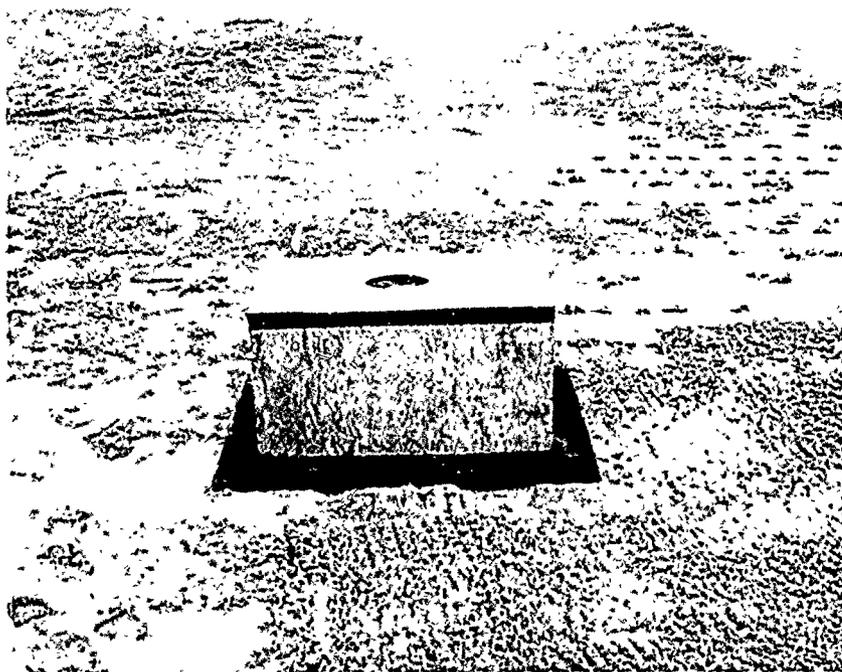
RDX pretest configuration
54. 43 kg (120 lb) charge weight

RDX posttest crater
54. 43 kg (120 lb) charge weight

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